S. F. ASHBY.

THE RUBBER RESEARCH INSTITUTE OF MALAYA

IMPERIAL MYCOLOGICAL INSTITUTE
20 OCT. 1936

ANNUAL REPORT 1935

Published by
The Rubber Research Institute of Malaya
and printed by
Kyle, Palmer & Co., Ltd.
Kuala Lumpur, F.M.S.

August 1936

Price $1/-

THE RUBBER RESEARCH INSTITUTE of MALAYA

Members of the Board

JUNE 1936

The Director of the Institute (Lieut. Col. B. J. Eaton, o.b.e.)	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member appointed by the High Commissioner under section 5 (i) (b) of Enactment no. 14 of 1934
The Hon'ble the Director of Agriculture, S.S. and Adviser on Agriculture, Malay States	*Ex officio*
Che Hamzah bin Abdullah, m.c.s. Orang Kaya Kaya Stia Bijaya di-Raja, Perak (Che Mohamed Noordin bin Abdul Shukur, i.s.o.)	appointed by the High Commissioner under section 5 (i) (d) of Enactment no. 14 of 1934
Mr. A. P. Cranna Mr. Choo Kia Peng, c.b.e., j.p. Mr. J. S. Ferguson, j.p. The Hon'ble Mr. B. J. R. Barton Mr. J. C. Innes, j.p.	appointed by the High Commissioner under section 5 (i) (e) of Enactment no. 14 of 1934

The Permanent Committee

The Director of the Institute	Chairman, *ex officio*
The Hon'ble the Financial Adviser, F.M.S.	Financial Member, *ex officio*
Mr. A. P. Cranna Mr. Choo Kia Peng, c.b.e., j.p. Mr. J. C. Innes, j.p.	appointed by the High Commissioner under section 13 (i) (c) of Enactment no. 14 of 1934

CONTENTS

	Page
Report of the Board	1
Statement of Accounts	6
Report of the Director	14
„ „ „ Soils Division	61
„ „ „ Botanical Division	70
„ „ „ Pathological Division	101
„ „ „ Chemical Division	117
„ „ „ Experiment Station	133
Report of the London Advisory Committee for Rubber Research (Ceylon and Malaya)	148

PUBLICATIONS

Publications of the Rubber Research Institute are issued in the following forms at prices stated at time of publication :

(a) Planting Manuals being articles of an instructional nature primarily for estates use. These appear at irregular intervals.
(b) Bulletins being articles of special scientific interest printed and bound separately, appearing occasionally
(c) Journal R.R.I. being articles by officers of various divisions of the Institute on current work, all bound as one volume, appearing at irregular intervals as information accumulates during the year
(d) Annual Reports of the work of each Division during each year, with summary by the Director R.R.I.
(e) Information Cards being concise precis of the processes of phases of estate factory practice.

The following publications have been issued and copies can be obtained on application at the prices given against each :—

(a) Planting Manuals

No. 1, "Preparation of Plantation Rubber" by B. J. Eaton	...	$2.00
No. 2, "Budding of Hevea in Modern Plantation Practice" by F. Summers	...	$2.00
No. 3, "Plantation Sheet Rubber Manufacture" by R. O. Bishop	...	$2.00
No. 4, "Latex Preservation and Shipment" by R. O. Bishop and R. G. Fullerton	...	$2.00
No. 5, "The History and Description of Clones of Hevea Brasiliensis" by C. E. T. Mann and C. C. T. Sharp		
Illustrated by H. C. Chuan	...	$2.00
Stiff cover for filing the leaflets	...	$1.00
No. 6, "The Uses and Control of Natural Undergrowth on Rubber Estates" by W. B. Haines (out of print)	...	$1.00
Binder cover for filing the Manual	...	$0.50

(b) Bulletins

No. 1, "Natural Coagulation of Hevea Latex" by A. S. Corbet (out of print)	...	$1.00
No. 2, "A Study of the Effect of Damp Storage on Raw Rubber" by B. J. Eaton and R. G. Fullerton	...	$1.00
No. 3, "The Root Disease Problem on Old Rubber Areas in Malaya" by A. Sharples and A. R. Sanderson	...	$1.00
No. 4, "Summary of Meteorological Records, Soils Division" by W. B. Haines	...	$1.00
No. 5, "Variations in the Composition of Latex from Clone and Seedling Rubber" by J. L. Wiltshire	...	$1.00

(c) Journal of the R.R.I.

Vol. 1 Nos. 1, 2—two numbers combined	...	$1.00
Vol. 1 „ 3, 4 Vol. 2 „ 1, 2, 3, 4 Vol. 3 „ 1, 2, 3 Vol. 4 „ 1, 2 Vol. 5 „ 1, 2, 3, 4 Vol. 6 „ 1, 2 — each number	...	$0.50

(d) Annual Reports

from 1928 each	...	$1.00

(e) Information Cards

dealing with various Phases of Rubber Estate Factory Practice and Defects in Raw Rubber		
in Malaya	...	$0.50
outside Malaya	...	$1.00

Bank commission should be added to outstation cheques.

REPORT OF THE BOARD

FOR THE

YEAR ENDED 31ST DECEMBER, 1935

THE BOARD

The constitution of the Board is

(a) The Director of the Institute—Chairman
(b) A Financial Officer appointed by the High Commissioner
(c) The Director of Agriculture, S.S. and Adviser on Agriculture, Malay States
(d) Two members appointed by the High Commissioner to represent the interests of small-holders
(e) Five members appointed by the High Commissioner from a panel of twelve persons nominated by Planting Associations

At the 31st December, 1935, the personnel was

(a) Lt. Col. B. J. Eaton, O.B.E.
(b) The Hon'ble Mr. L. Rayman, M.C.S.
(c) The Hon'ble Dr. H. A. Tempany, C.B.E.
(d) Che Hamzah bin Abdullah, M.C.S.
Che Mohamed Noordin bin Abdul Shukor, I.S.O.
(e) Mr. A. P. Cranna
Mr. J. C. Innes, J.P.
Mr. Choo Kia Peng, C.B.E., J.P.
Mr. J. S. Ferguson, J.P.
The Hon'ble Mr. B. J. R. Barton

Dr. Tempany was on leave from the 1st January to the 22nd February and from the 26th June to the 1st October, during which periods Mr. F. W. South acted for him on the Board.

Mr. Cranna was on leave from the 1st January to the 11th July; Mr. Innes from the 19th January to the 25th September; and Mr. Barton from the 1st to 13th January. During these periods Mr. E. H. H. Everest, the Hon'ble Mr. J. Robertson and the Hon'ble Mr. W. Miller Mackay served on the Board.

THE PERMANENT COMMITTEE

The members of the Permanent Committee of the Board appointed by the High Commissioner are

Mr. A. P. Cranna
Mr. J. C. Innes
Mr. Choo Kia Peng

with the Director of the Institute and the Financial Officer as *ex officio* members.

Meetings of the Board and Committees

During 1935 the number of meetings of the Board and Committees were

Board—ordinary meetings	...	...	3
Board—special meetings	...	...	1
Permanent Committee	...	...	4
ad hoc Committees	...	...	3
			11

The Rubber Roadways Committee

The Rubber Roadways Committee is an ad hoc Committee appointed in 1931 for the purpose of conducting investigations into the utilisation of rubber and/or latex in the surfacing of roads. Considerable research work was done in the laboratories of the Institute during the period 1931/4 and a satisfactory mixture of latex and cement was evolved. A few large-scale trial plots subjected to traffic in Kuala Lumpur demonstrated, however, that there was room for improvement in the preparation of the mix and the technique of applying it to roadways, and after consultation with the London Advisory Committee for Rubber Research (Ceylon and Malaya) the Board decided that further research could with greater advantage be done in laboratories in England. It was therefore decided in 1935 to discontinue work in Malaya and to co-operate with the London Committee. To this end the Board made a grant to the London Committee of £1,000 per annum for each of three years 1935—1937 for the purpose of prosecuting laboratory research in England, and has agreed to collaborate in any further trials in Malaya if the London Committee desires such trials to be made.

The Revenue of the Institute

The income of the Institute is derived from

(a) contributions by Malayan Governments from an export duty on rubber from Malayan territories;

(b) sales of rubber produced at the R.R.I. Experiment Station at Sungei Buloh;

(c) interest on investments and sales of publications.

The contributions under (a) are made from the Rubber Funds established by the Rubber Regulation Ordinance of the Straits Settlements and the analogous Enactments of the Federated

Malay States and the States of Johore, Kedah, Kelantan and Trengganu. The duty imposed thereunder is 0.7 of a cent per lb. of rubber exported, and the amount allocated during 1935 to the purposes of the Institute by the several Administrations was at the rate of 4½ cents per pikul of the Malayan basic quota, equivalent to 0.049 of a cent per lb. of rubber exported.

The contributions received and payable for the year 1935 are:—

	$ c.	Percentage of the total
Federated Malay States ...	216,858.60	53.57
Johore	91,476.00	22.60
Kedah	43,848.00	10.83
Kelantan	10,206.00	2.52
Trengganu	4,914.00	1.22
Straits Settlements ...	37,479.24	9.26
	404,781.84	

The following table shows the quantity of rubber in tons estimated to have been produced in and exported from the Federated Malay States, the Unfederated Malay States and the Colony of the Straits Settlements, for each year from 1929 to 1935:—

	F.M.S.	Johore	Kedah	Kelantan	Trengganu	Perlis	Brunei	Straits Settlements	Total
1929	261,353	89,296	39,298	8,042	2,212	291		50,061	450,553
1930	250,122	90,639	38,303	7,375	1,998	266		45,929	434,632
1931	244,149	90,778	40,290	6,593	1,860	196		30,198	414,064
1932	235,892	86,686	39,044	5,171	1,817	159		36,936	405,705
1933	250,550	96,941	47,121	9,290	2,456	323		43.261	449,942
1934	269,867	103,528	52,254	11,573	4,002	516		46,201	487,941
1935	197,144	83,178	39,830	9,223	4,533	360	1,338	35,079	370,685
Percentage of the total in 1935	53.18	22.44	10.75	2.49	1.22	0.09	0.36	9.47	

No contributions were made from the States of Perlis and Brunei, but the Government of Brunei has agreed to contribute from the 1st January, 1936.

Accounts for the Year 1935

Subjoined are the Income and Expenditure Account for the year 1935 and the Balance Sheet as at the 31st December 1935.

From the former it will be seen that the income from cess is $404,781.84 for 1935, and $67.77 short-paid in 1934; the recurrent expenditure (excluding depreciation) is $363,882.27 and special expenditure $24,455.12, making the total expenditure $388,337.39. Miscellaneous receipts (interest on investments, sales of rubber and publications, rents of houses) amount to $16,721.03.

From the balance sheet it will be observed that the total excess of assets over liabilities is ... $1,410,949 96

represented by

Land, Buildings and Furniture ...		433,132 89
Plant, Machinery and Apparatus ...		28,755 80
Experiment Station ...		461,769 35
Stocks ...		2,238 36
Sundry Debtors ...		39,006 66
Investments ...		346,934 19
Cash ...		153,159 69
		$1,464,996 94
Less Sundry Creditors:		
Miscellaneous ...	$14,155 71	
Reserve for Staff leave-pay and passages ...	33,244 41	
Rubber Roadways Committee —balance of grant from the Rubber Experimental Research and Propaganda Fund ...	6,646 86	54,046 98
		$1,410,949 96

The realisable investments and available cash amount to approximately $485,053 from which will be met the expenditure of $230,000 for the erection and equipment of new laboratories and offices, and approximately $20,000 for the equipment of the factory at the Experiment Station.

Institute Buildings

In the Annual Report for 1933 the necessity for a permanent building for the Institute to replace the present temporary accommodation was explained. During 1935 the Board decided to

proceed with the erection of new buildings on the Board's land at the 3rd mile Ampang Road, Kuala Lumpur, and in December a contract was signed. It is expected that the buildings will be erected and fully equipped during the second half of 1936.

Small-holders' Advisory Service

Five more appointments of Asiatic Rubber Instructors were made in 1935 bringing the total to fourteen. Eight appointments to complete the original approved cadre of 22 remain to be made in 1936, and in addition the Board has approved the appointment of an Instructor for service in Brunei.

The Board has approved the principle of conducting experiments in replanting areas of half to one acre in small-holdings, and if practicable a commencement on this work will be made in 1936. The value of replanting comparatively large areas on estates has been demonstrated, but it has not been established whether the replanting of an area as small as half an acre surrounded by mature trees is an economic proposition. Further reference to this subject will be found in the report of the Director.

Activities of the Institute in 1935 and 1936

The activities of all Divisions of the Institute were seriously curtailed in 1935 owing to shortage of staff and incidence of home leave. In the second half of the year, however, three new officers were recruited, and three more will be appointed in 1936, when the Institute may be considered to be again adequately staffed. It will then be possible to proceed with a scheme for the initiation of numerous experiments over the area of approximately 8,000 acres which by the terms of the International Rubber Regulation Agreement may be devoted to experimental planting.

B. J. Eaton

Chairman of the board

H. S. Blacklin

Secretary

Kuala Lumpur

February, 1936

INCOME AND EXPENDITURE ACCOUNT

Dr.

EXPENDITURE

		$	c.	$	c.
To	Experiment Station			59,014	25
„	Board and Committees (Fees and Expenses) ...			1,946	89
„	London Advisory Committee			11,987	01
„	London Secretarial Fees and Expenses			896	40
„	Salaries and Allowances			158,302	16
„	Provident Fund			15,142	76
„	Staff Leave Pay			17,141	00
„	Rubber Roadways Research			8,571	48
„	Medical			1,311	76
„	Travelling			8,525	31
„	Office General Charges (Printing, Stationery, Postage, Telephone, Audit, Legal)			4,180	23
„	Staff Recruiting			361	53
„	Rents, Rates and Insurance			4,274	02
„	Laboratory General Charges			893	96
„	Upkeep Buildings (Offices and Residential Houses)			5,744	27
„	Upkeep Laboratory Grounds			1,453	77
„	Upkeep Furniture			1,740	34
„	Plant and Machinery (Upkeep and running expenses)			7,282	06
„	Lorry (running expenses)			2,253	98
„	Workshop			156	39
„	Laboratory Apparatus and Glassware			4,871	29
„	Laboratory Chemicals			2,157	72
„	Publications issued by the Institute			4,535	59
„	Library (New books, Subscriptions to Periodicals and sundries)			3,861	46
„	Exhibitions and Demonstrations			372	77
„	Small Holders' Advisory Service				
	Film Propaganda	994	35		
	Asiatic Rubber Instructors	17,291	08		
	Grant to Department of Agriculture for Vernacular Publications	2,000	00	20,285	43
„	Experiments (Field and Testing Laboratory) ...			16,618	44
„	Depreciation for year			48,745	00
				412,627	27
„	Balance being Excess of Income over Expenditure for year carried to Balance Sheet			23,403	23
				$436,030	50

KUALA LUMPUR
13th February, 1936

FOR THE YEAR ENDED **31st DECEMBER, 1935**

Cr.

INCOME

		$	c.	$	c.
By	Contributions by Administrations for the year ...			404,849	61
„	Interest on Cash and Investments			14,459	86
„	Miscellaneous Receipts :—				
	Sales of rubber and budwood	7,638	11		
	Sales of publications	1,320	85		
	House rentals	6,369	22		
	General	1,392	85	16,721	03
				$436,030	50

(Sgd.) B. J. EATON
Chairman of the Board

(Sgd.) H. S. BLACKLIN
Secretary

(Inld.) G. A. B. & Co.

BALANCE SHEET AS AT

LIABILITIES

	$	c.	$	c.
Sundry Creditors			13,151	84
Deposits for Publications			883	16
Reserves:				
Staff Leave Pay and Passage				
Laboratory	25,403	43		
Experiment Station	7,840	98	33,244	41
Rubber Roadways Committee			6,646	86
Suspense			120	71
Excess of Assets over Liabilities:				
Balance as at 1st January, 1935	1,387,546	73		
Add Excess of Income over expenditure for year	23,403	23	1,410,949	96

(Note:—There is a contingent liability of $230,000 for the erection and equipment of new laboratories and offices)

Carried forward ...	$1,464,996 94

31st DECEMBER, 1935

ASSETS

	$	c.	Depreciation for year $	c.	$	c.	$	c.
LAND AND BUILDINGS:								
132 Ampang Road								
Land as at 1.1.35 ...					10,755	00		
Ampang Villa as at 1.1.35	16,250	62	1,015	66	15,234	96		
132a Ampang Road								
Building as at 1.1.35 ..	36,939	13	2,308	68	34,630	45	60,620	41
Land behind Ampang Villa as at 1.1.35							5,029	35
5 Circular Road								
Land as at 1.1.35 ...					17,147	08		
Old Building as at 1.1.35	12,657	70	791	11	11,866	59		
Three Houses as at 1.1.35	66,852	51	4,178	28	62,674	23	91,687	90
163 Ampang Road								
Land as at 1.1.35 ...					31,440	35		
Old Building as at 1.1.35	11,753	74	734	60	11,019	14		
Five Houses as at 1.1.35	78,793	76	4,924	61	73,869	15	116,328	64
184/8 Ampang Road								
Land as at 1.1.35 ...					45,422	50		
Five Houses as at 1.1.35	71,831	37	4,249	78	67,581	59	113,004	09
LABORATORY BUILDINGS:								
As at 1st January, 1935 ...	11,467	17	11,466	17	1	00		
New Laboratory Buildings								
Cost to date	1,182	51	10	00	1,172	51	1,173	51
PLANT AND MACHINERY:								
Electric Plant								
As at 1st January, 1935	1,729	39	432	35	1,297	04		
General Machinery								
As at 1st January, 1935	10,577	67						
Additions during year ...	732	00						
	11,309	67	1,696	45	9,613	22	10,910	26
FURNITURE:								
Residential Houses								
As at 1st January 1935	25,956	98	1,946	77	24,010	21		
Office								
As at 1st January 1935	8,616	91	646	27	7,970	64		
Laboratory								
As at 1st January 1935	1,814	57	136	09	1,678	48		
Store								
As at 1st January 1935	155	84	155	84	—			
Library								
As at 1st January 1935	777	73	58	33	719	40	34,378	73
Carried forward ...			34,750	99			433,132	89

LIABILITIES—*(Contd.)*

	$	c.
Brought forward ...	1,464,996	94
Carried forward ...	$1,464,996	94

31st DECEMBER, 1935

ASSETS—*(Contd.)*

			Depreciation for year					
	$	c.	$	c.	$	c.	$	c.
Brought forward ...			34,750	99			433,132	89
LABORATORY EQUIPMENT AND APPARATUS:								
As at 1st January 1935	32,214	71						
Additions during year ...	1,830	00						
	34,044	71	6,442	94			27,601	77
MOTOR LORRY:								
As at 1st January 1935	861	05	215	26			645	79
WORKSHOP EQUIPMENT:								
As at 1st January 1935	597	93	89	69			508	24
R.R.I. EXPERIMENT STATION:								
Development Expenditure as at 1st January 1935	448,294	86						
Additions during year ...	20,720	61						
	469,015	47	7,246	12			461,769	35
Total depreciation ...			$48,745	00				
LIBRARY BOOKS AND PERIODICALS:								
As at 1st January 1935					1	00		
Add Purchases during year					2,875	16		
					2,876	16		
Less written off ...					2,875	16	1	00
STOCKS:								
Petrol and oil								
Laboratory	209	87						
Experiment Station ...	101	20			311	07		
Empty Drums								
Laboratory	213	00						
Experiment Station ...	126	00			339	00		
Stationery					608	17		
Sundry Materials								
Laboratory	147	16						
Experiment Station ...	831	96			979	12	2,237	36
SUNDRY DEPOSITS for water, telephones, etc.								
Laboratory					230	00		
Experiment Station ..					20	00	250	00
SUNDRY DEBTORS:								
Administrations ...					21,473	55		
Staff					11,700	25		
Accrued interest ...					4,528	28		
General					530	29		
At Experiment Station ..					524	29	38,756	66
Carried forward ...							964,903	06

BALANCE SHEET AS AT

LIABILITIES—*(Contd.)*

	$	c.
Brought forward ...	1,464,996	94

(Sgd.) H. S. BLACKLIN
Secretary

(Sgd.) B. J. EATON
Chairman of the Board

	$1,464,996 94

I hereby certify that, to the best of my knowledge and belief, all

Kuala Lumpur
13th February, 1936

We have audited the above Balance Sheet and Income and Expenditure
Malaya and certify same to be correct according to the best of our information

Kuala Lumpur,
15th February, 1936

31st DECEMBER, 1935

ASSETS—*(Contd.)*

	$ c	$ c.	$ c.	$ c.
Brought forward ...				964,903 06
INVESTMENTS :				
F.M.S. Government 4½% Loan 1931/59				
Nominal value, $172,800/-			183,922 07	
Singapore Municipal 4½% Loan 1930/70				
Nominal value, $15,000/-			17,536 69	
British 3½% War Loan, 1932/54				
Nominal value, £17,000			145,475 43	346,934 19
CASH AT BANK AND IN HAND :				
London Advisory Committee for Rubber				
Research (Ceylon and Malaya) ...			946 86	
Chartered Bank, London			3,585 46	
Chartered Bank, Kuala Lumpur				
Board's Account ...		90.435 95		
Rubber Roadways Committee		6,646 86		
Working Account ...		47,062 21		
Experiment Station ...		4,271 91	148,416 93	
Petty Cash				
Secretary	45 90			
Imprest advances ...	90 00	135 90		
Experiment Station ...		74 54	210 44	153,159 69
				$1,464,996 94

liabilities to 31st December, 1935, have been brought into account.

(Sgd.) H. S. BLACKLIN
Secretary

Account with the books and vouchers of the Rubber Research Institute of and the explanations given to us and as shewn by the books of the Institute.

(Sgd.) GIBSON, ANDERSON, BUTLER & CO.
Chartered Accountants
Auditors

ANNUAL REPORT

OF

THE DIRECTOR

Introduction

The past year has been one of considerable difficulty since, chiefly owing to leave exigencies the full effect of previous retrenchment and other losses have been experienced. The Senior Officers of the Botanical, Chemical and Soils Divisions were on leave for a considerable part of the year leaving a single officer in each of these divisions and in the Pathological Division. The Soils Division was in charge of the only Advisory Officer who also assisted in the advisory work of the Chemical Division.

In spite of this shortage, however, research work in progress was maintained although it was not possible to embark on any new investigations. Some delay in dealing with advisory work was also inevitable on occasions, since the number of requests for advice by letter or visits is increasing.

It is satisfactory to be able to state, however, that the situation was alleviated towards the end of the year by the return of officers from leave and the arrival of several new officers to fill vacancies. Details relating to the various Divisions are given below.

Staff

Director

The writer continued to act as Director of the Institute during the year, but tendered his resignation to take effect from the end of his period of agreement. The necessary steps were taken for the appointment of a new Director.

Botanical Division

Mr. C. E. T. Mann, Senior Officer, proceeded on leave on the 12th July, 1935, and was absent for the remainder of the year. Mr. C. C. T. Sharp returned from leave on the 16th June, 1935, and acted as Senior Officer during the absence of Mr. Mann.

Mr. H. Gunnery resigned his appointment with effect from the 20th July, 1935.

Chemical Division

Dr. E. Rhodes, Senior Officer, proceeded on leave on the 25th January and returned on the 4th September, 1935.

During his absence Mr. J. D. Hastings was in charge of all research investigations, while Mr. A. Moore, Advisory Officer, assisted in the advisory work of the Division.

Dr. K. C. Roberts, who was appointed to fill the vacancy caused by the death of Dr. J. L. Wiltshire at the end of 1934, arrived and assumed duty on the 2nd August.

Mr. J. H. Piddlesden, who was appointed to fill the remaining vacancy in the Division, arrived and assumed duty on the 19th July.

Pathological Division

Mr. R. P. N. Napper, who proceeded on leave on the 28th December, 1934, returned and resumed duty on 28th December, 1935.

Soils Division

Mr. C. G. Akhurst, Senior Officer, who proceeded on leave on the 28th December, 1934, returned and resumed duty on the 6th October, 1935.

Mr. A. Moore, Advisory Officer, was in charge of the Division during the absence of Mr. Akhurst.

Mr. R. A. Hamilton, Soils Chemist, who was appointed to fill the vacancy in the Division arrived and assumed duty on the 5th October, 1935.

Office

Mr. H. S. Blacklin continued as Secretary throughout the year.

Library

Mr. H. S. Blacklin was in charge of the Library in addition to his duties as Secretary.

Experiment Station

Mr. H. W. Foston continued to serve as Manager of the Experiment Station.

Mr. T. N. Dickson was appointed Assistant Manager with effect from the 1st July, 1935.

General

The vacant appointments in the Chemical Division were filled, so that the Division was at full strength during the last four months of the year.

Owing to Mr. Gunnery's resignation it became necessary to recruit another officer for the Botanical Division.

On account of the large amount of field experimental work and advisory work, in relation particularly to replanting problems and experimental planting, the Board also agreed to the appointment of an additional officer in the Botanical Division.

Steps were taken to recruit two officers, but only one was selected and had not arrived at the end of the year. (Note:—The selected officer, Mr. E. D. C. Baptist has since arrived on March 20, 1936). Another officer was selected but subsequently withdrew his application.

The Board also approved an additional Advisory Officer for 1936.

The difficult situation existing therefore during 1934 and 1935 caused by the retrenchments effected in 1932 has now been considerably ameliorated and it will be possible for divisions to make more rapid progress with numerous problems awaiting solution.

Advisory Work.

A very large amount of advisory work has been accomplished by correspondence, by visits of officers to estates and by visits from managers to consult officers at the Institute and the Experiment Station. A number of lectures have also been given during the year at various centres.

Apart from individual visits to estates, the following tours were arranged for specific purposes.

State	*Object*	*Visiting Officer*
Perak	Inspection of budded areas	C. E. T. Mann
Perak	Advice on factories and smoke houses and soils investigations	A. Moore
Perak	Soils investigations	C. G. Akhurst
Perak	Oidium leaf disease	F. Beeley
Perak and Kedah	Advice on factory organization and soil investigations	A. Moore
Perak and Kedah	Oidium leaf disease	F Beeley
Negri Sembilan (2)	Soils investigations	A. Moore
Negri Sembilan	Soils investigations and inspection of experimental areas	C G. Akhurst
Negri Sembilan and Johore	Advice on factories and smoke houses and soils investigations	A Moore

Negri Sembilan, Malacca and Johore	Oidium leaf disease	F. Beeley
Kedah and Province Wellesley	Soils investigations	C. G. Akhurst

The principal features in relation to advisory work have been in relation to tapping systems on both mature seedling trees and budded trees, selection of clones for planting and replanting, the planting of clonal seed, *Oidium Heveae* leaf disease, root diseases, identification of natural covers, manuring and cover plants, preservation and shipment of latex and the drying and smoking of sheet rubber.

One feature is the number of enquiries relating to what may be described as elementary planting problems, since quite a number of present planters have had no experience in opening up areas and planting seeds in nurseries or in the field. It has been seriously proposed that the Institute should prepare a Manual on "Elementary Planting". While admitting the probable utility of such a publication, the writer suggests that this might well come within the scope of the educational scheme of the Incorporated Society of Planters and could be accomplished by the revision of "*Planting Queries*" setting out concisely established practice as qualified by present knowledge in the form of instructions for the early stages of planting. This suggestion has been submitted to the Society for consideration.

During the year 4886 letters, including 3399 enquiries on planting problems have been received and 3792 letters or reports have been despatched, exclusive of those dealing with the Institute's publications and miscellaneous correspondence.

The principal enquiries in relation to estate practice and planting problems are given in the following summary:—

Cover plants, cultivation of natural covers and soil conservation	...	246
Manuring	...	207
Replanting	...	273
Budding and Selection	...	315
Cover plants (Identification)	...	81
Tapping (including experimental work)	...	314
Root diseases	...	99
Stem and bark diseases	...	65
Leaf diseases	...	141
Latex Preservation and Concentration	...	200

Smoke houses and smoked sheet	...	260
Coagulants and rubber preparation	...	94
Estate factory machinery and plant	...	53
Special enquiries in connection with rubber assessment and experimental planting	...	116

The increase in the number of enquiries relating to manuring, replanting, budding and seed selection compared with 1934 will be noted.

In addition there has been a large amount of correspondence with the Controller of Rubber, Malaya, and various estates in relation to the planting of reserve areas for experimental purposes, to which further reference will be made later.

Correspondence on problems concerning latex and raw rubber has also been maintained with the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya) in respect of investigations in which collaboration is being effected.

A detailed summary of the advisory correspondence of each Division is published as an Appendix to the Director's report.

Small-Holders' Advisory Service

The Small-Holders' Advisory Service has been supplemented during the year by the appointment of four additional Malay Instructors and one additional Indian Instructor who, after a special refresher course on leaving the School of Agriculture, Malaya, were allocated to various districts in July 1935.

During the year also the previously appointed Instructors were transferred in some cases to other districts. At the end of the year the distribution of the Instructors was as follows —

Perak	...	3 (1 Indian)
Selangor	...	2 (1 Indian)
Negri Sembilan	...	1
Pahang	...	2
Johore	...	2
Kedah	...	1
Kelantan	...	1
Malacca	...	1
Province Wellesley & Penang	...	1

It was unfortunately not possible to recruit any Chinese Instructors from the School of Agriculture but some will be available during 1936. (Note.—Three Chinese and one Malay have since been appointed in 1936).

As a result of a request from the State of Brunei to contribute towards the maintenance of the Institute, it was agreed to appoint one additional Malay Instructor to be allocated to that State when available during 1936 and it was agreed that this Instructor should also visit Labuan (S.S.).

One of the Instructors in Pahang was again loaned for a short period to the State of Trengganu.

As a result of experience, a modified format for the Monthly Reports prepared by Instructors was drawn up by the Director of the Institute in order to lessen the amount of typing and to render the reports more readable. Instructions were also circulated showing how reports could be shortened without affecting their value.

In most cases, the reports forwarded are excellent and indicate the value of the work being carried out by the Instructors among small-holders. The value of such work is also indicated in other ways, reference to which are made below.

In some districts e.g. in parts of Perak, Negri Sembilan and Johore, the existence of root diseases on small-holdings is greater than was supposed.

Rubber tapping in small holdings is affected during the padi planting and harvesting seasons, when tapping ceases on a number of holdings owned by Malays who also own padi land. This is particularly the case during the present period of regulation of rubber exports, since the small-holders have been able to sell their coupons at high prices.

The sale of coupons with the consequent cessation of tapping on a large number of small holdings has also had one bad and one good effect. In the first instance it has caused unemployment among the labourers employed for tapping by small-holders, which is not a satisfactory feature; on the other hand, the sale of coupons and cessation of tapping, especially during the rainy weather in the last quarter of the year, has resulted in a considerable decrease in the incidence and virulence of Mouldy Rot disease of the tapping panel, thus improving the general health of the trees. The resting of the trees is also beneficial in relation to the excessive bark consumption on small-holdings.

Considerable improvement in the control of natural undergrowths has been effected, partly as a result of the advice of the Instructors and partly because the small-holder realizes that he is likely to get a better assessment if his holding has been cleaned up.

Advice has been concentrated principally on the treatment of Mouldy Rot disease, lighter tapping with a lower bark consumption and the preparation of smoked sheet rubber.

Approved fungicides for the treatment of Mouldy Rot disease have been distributed at cost price through officers of the Department of Agriculture.

The outbreak of *Oidium Heveae* leaf disease was not serious on any small-holdings during the refoliation period.

Considerable improvement has been effected in a number of districts in the preparation of smoked sheet rubber as a result of propaganda and advice given. Each Instructor is provided with certain equipment and material, in the form of coagulating pans, coagulants etc. for demonstration purposes.

As a result of an observation made by one of the Malay Instructors on a small-holding in Perak, the Institute has evolved a satisfactory smoke house for small-holders, which is suitable for an area of about 12 acres and is thus large enough normally for three or four holders. The particular advantages of this smoke house are its cheapness and efficiency. A full description of the smoke house has been published in the Institute Journal and also in the Malay and Chinese vernacular publications of the Department of Agriculture. The Instructors have also given assistance to small-holders in the erection of these smoke houses.

As a result of propaganda, including that carried out by means of the Rural Lecture Caravan, a large number of these smoke houses have now been erected throughout Malaya and are working very satisfactorily.

Numerous demonstrations have been given by Instructors at District Agri-Horticultural Shows and to groups of small-holders in various centres.

It has still to be impressed on many small-holders however that cleanliness is essential in all stages of collection and treatment of latex for the preparation of high grade sheet rubber which will fetch a market price equivalent to that from large estates. Another important point is the use of satisfactory hand rollers to produce a sufficiently thin sheet which can be dried and smoked within a reasonable time.

In order to encourage the preparation of smoked sheet it has been decided in future not to include air-dried or unsmoked sheet in the competition for small-holders' rubber at the Annual Malayan Agri-Horticultural Association Exhibition.

Another interesting and useful procedure adopted by one Instructor in Pahang through the local authorities is to arrange for dealers to exhibit various grades of sheet rubber with relative prices, so that the small-holder can compare his produce and its market value with the samples exhibited. It is hoped after further trial to extend this procedure.

It has not so far been possible to encourage co-operative selling or preparation on a co-operative basis.

In some districts progress is slow, chiefly owing to the fact that on some holdings a fixed rate is paid for the amount of rubber prepared and the labourer, who taps the tree, coagulates the latex and machines and dries or smokes the rubber is not likely to spend much care on the various operations, unless some benefit accrues to himself.

Another valuable investigation carried out as a result of the efforts of the Instructors has been the examination of the coagulants used in various districts.

Although in certain districts satisfactory coagulants such as formic and occasionally acetic acid are used, in others sulphuric acid is used very extensively. In three States, over an area of about one million acres, sulphuric acid is used on about one-third of the area. Efforts are being made by means of propaganda and advice given personally by the Instructors to discourage the use of this acid.

Useful work has also been effected on Indian holdings which are largely owned by Chettiars. The principal difficulty has been to get in contact with the owners who live in the towns and not on their holdings. All Chettiar Chambers of Commerce have been circulated informing them of the scheme and offering the services of the Indian Instructors and of any additional advice and assistance by the Institute.

Mr. W. I. Pieris, newly appointed as Adviser for Rubber Small-Holdings in Ceylon under The Rubber Research Scheme, Ceylon, paid a visit to Malaya during the year to study the Small-Holders' Advisory Service in Malaya before embarking on a similar scheme in Ceylon.

In concluding these observations on the Small-Holders' Advisory Service, I wish to take this opportunity of expressing my opinion, which is shared by the Director of Agriculture S.S. and Adviser on Agriculture Malay States as to the potential value of this service to the small-holder; the cost of the scheme will be repaid several times over by an increase of only 1 cent per lb. in the value of the rubber prepared, apart from any other benefits derived.

One ill-informed critic, who has no knowledge of the scheme or its operation has described it as "eye-wash". It is hoped that the brief observations above of the progress already made will convince him and any other critics of the importance and value of such work among small-holders who are responsible for about 45 per cent of the production of rubber in Malaya and who are not in a position to take advantage of other improvements adopted by large estates.

Rural Lecture Caravan

The Rural Lecture Caravan, jointly operated by the Co-operative Societies Department S.S. & F.M.S., the Department of Agriculture S.S. & F.M.S., and this Institute has continued to function satisfactorily during the year. Lectures, illustrated by lantern slides dealing with the treatment of Monthly Rot and the preparation of smoked sheet rubber have been given by Rubber Instructors attached to the Caravan during its tours in various districts.

The following tours have been made:—

Perak	Perak South	Eight centres
	Krian	Five "
	Larut & Matang	Twenty-one centres
Selangor	Kuala Langat	Four centres
	Klang	Three "
	Kuala Selangor	Seven "
Negri Sembilan	Rantau & Jelebu	Four "
	Kuala Pilah	Seven "
	Tampin	Three "
	Seremban—P.Dickson	Nine "
Pahang	Kuala Lipis	Six "
	Raub	Four "
Malacca	Alor Gajah	Three "
	Malacca Central	Three "
	Jasin	Three "
Penang	South West District	Four "

In addition the caravan was present at the Agricultural Show held in Muar, Johore.

Co-operation with Malayan Institutions

The Director has continued to serve on the following Committees:—

(i) The Advisory Committee of the Department of Agriculture, S.S. & F.M.S.
(ii) The Publicity Committee of the Department of Agriculture, S.S. & F.M.S.
(iii) The Public Gardens' Committee (Kuala Lumpur).
(iv) The Marketing and Propaganda Committee of the Co-operative Societies Department, S.S. & F.M.S.
(v) The Advisory Committee of the School of Agriculture, Kuala

Co-operation with other Institutions

Close contact has been maintained with the work carried out in the laboratories of the London Advisory Committee for Rubber Research (Ceylon and Malaya) by means of correspondence and exchange of reports on work in progress.

Correspondence on matters of mutual interest has been carried on with the rubber research organisations in Netherlands India, *viz.*, The A. V. R. O. S. Proefstation in Sumatra and the Proefstation West Java, also with private research organisations such as the Holland American Plantations Research Department in Sumatra and the Goodyear Plantations Research Department, Sumatra. Collaboration with the Rubber Research Scheme, Ceylon, through the London Advisory Committee and by direct correspondence has also been maintained. Contact with the Research Association of British Rubber Manufacturers has been maintained on a few problems of mutual interest.

As a result of the visit paid to the United States of America by Dr. Rhodes, a Committee of the Rubber Division of the American Chemical Society has been formed with the primary object of promoting a better understanding between the producers and consumers of crude rubber and to act as a clearing house between the two groups for information on the quality requirements for various crude rubbers, including latex; to exchange opinions on the value of new types of crude rubber etc. The Committee will concern itself only with the technical aspects of the problem and will deal only with those items which can be handled through recognised technical agencies allied with the producers.

It is anticipated that this Committee will be of considerable value in enabling us to ascertain the opinions and requirements of American rubber manufacturers and latex consumers.

In this connection it is of considerable interest to record that one of the largest American tyre manufacturing firms has established a rubber testing laboratory in Kuala Lumpur and has a staff of three Chemists engaged on investigations on Malayan raw rubber.

Collaboration has continued with the Technical Research and Development of New Uses Committee of the Rubber Growers' Association and with the Rubber Producers Research Association —a subsidiary organisation—in connection with investigations on new uses for rubber and rubber derivatives suitable for specific purposes. Reports on the work are received periodically, so that we are kept in close touch with all stages of these investigations.

A scheme for the study of the physiology of latex production has been proposed by the Rubber Growers' Association to be carried out in certain institutions at home. Correspondence on

this problem, in relation particularly to the work already current at the Institute and the desirability of a satisfactory liaison, together with our observations on the scheme have been addressed to the Association.

All reports on the development of research on rubber roadways now being carried out in the laboratories of the London Advisory Committee are forwarded to the Institute. Further reference will be made to this work in the section on chemical investigations in progress.

In relation to collaboration with other rubber research organisations it is gratifying to note that the Netherlands India authorities have again agreed to continue the circulation of the publication "Archief voor Rubbercultuur", so that it will be possible to keep in touch with the research being carried out in Java and Sumatra by an exchange of our respective publications.

General

In relation to the question of research vis-a-vis advisory work it may be of interest to record that other research organisations have experienced the same difficulties encountered by us in carrying on fundamental research while at the same time rendering assistance or advice on individual problems affecting only one particular unit.

Thus recently when increasing the grant of the Shirley Institute of the Federation of the Master Cotton Spinners' Association, the Federation Committee " recognised that the great increase in the Institute's service to individual firms was largely responsible for the curtailment of the fundamental research for which the Association was primarily established. *They did not think it was desirable that such special services to individual members should be limited or curtailed, but in granting the increase they made it clear that they expect the Institute will more fully concentrate on fundamental research work.*"

The Board of the Rubber Research Scheme, Ceylon, has also found it necessary to issue a Circular to all estates in connection with the same question.

I should like to emphasize once again that this is a matter which must be left to the discretion of the Director of any scientific organisation connected with a specific industry since in many cases advisory work and research investigations are inseparable. Secondly it is essential that research officers should by means of advisory visits to estates keep in contact with the economic aspects of the application of their researches.

In an Institution such as the Rubber Research Institute I hold the opinion that advice on any particular investigation of a prob-

lem in the field is normally best given by an officer carrying out the "fundamental research" on the problem and that when so given it is generally more appreciated by the enquirer.

Soil Investigations

On account of leave exigencies during the year, laboratory investigations in relation to soils were considerably curtailed, but advisory work and field experiments already initiated were maintained. Fortunately Mr. Moore, Advisory Officer, was able to pay considerable attention to field experimental work in progress and to give advice by means of correspondence and numerous visits to estates on cover plants, manuring and replanting.

Towards the end of the year, on the return of the Senior Officer of the Division and the arrival of Mr. Hamilton, Soils Chemist, who has fortunately had previous tropical experience, it was possible to tackle again the various questions requiring attention so that considerable progress has been made during the early part of 1936.

Soil Regeneration

Although an Annual Report should perhaps contain only the results of investigations carried out during the year under review, on account of the importance of the problem of soil deterioration, it appears desirable to direct attention to its various aspects and to quote statements made by authorities in other countries in which attention is being paid to this vital matter.

A much saner view is being adopted of the value of natural or indigenous cover plants in improving soils which have become deteriorated owing to bad agricultural practice in the past.

As a result of (a) an article entitled "The Use of Natural Covers on Rubber Estates" published in the Institute Journal (Vol. 6 No. 1) in which the writer dealt with various views and criticisms published in the press, and of (b) a lecture by the writer given before the Annual Conference of the Incorporated Society of Planters, the scientific aspects of soil regeneration by the development in particular of some form of ground cover are now more fully appreciated by the planter.

As has been emphasized elsewhere, the problem has been discussed previously mainly on an academic basis, since there is at present no recognised technique for the acceleration in improvement of soils which have been deteriorated by many years of incorrect agricultural practice, whether due, in the case of rubber cultivation, to the prolonged cultivation of other crops previous

to the rubber tree, or to deterioration caused by rainfall erosion and the exposure of a bare soil to the tropical sun.

It is, however, now appreciated that, in addition to improving the humus content of the surface soil by the growing of cover plants, the application of artificial fertilisers is essential to accelerate improvement and to maintain a satisfactory balance between the main crop and the cover plants. Manuring therefore is complementary to the development of natural or other cover plants in soil improvement.

The proximity of patches of jungle in the vicinity of estates is a factor which has an important bearing on the rapidity with which indigenous cover plants are developed on soils which have been clean-weeded for many years, as this supplies a natural source of seed which are distributed by birds and animals. This can be observed frequently throughout the country.

Little is yet known of any satisfactory method of acceleration and growing of indigenous covers by the planting of seeds, cuttings or seedlings but experiments have been initiated. The existence of old silt pits and drains into which vegetation and surface soil have been washed by rain is also a factor affecting the germination of seed of indigenous or other plants, since the humus and moisture in the soil in such depressions constitutes a suitable germination bed, whereas any seed deposited by birds or animals on a hard bare soil may either be washed away or be unable to germinate until some improvement of the soil has been effected.

In considering "forestry methods" as between the forester and the agriculturist in the tropics, it has to be remembered that, in Malaya or other rubber producing countries in the east, the forester, in dealing with regeneration of trees, has been usually concerned with practically virgin soils which have not been deteriorated by exposure to sun and erosion by rainfall, whereas the problem of the agriculturist, in this instance the rubber planter in relation to "mature" rubber trees, is the regeneration of a soil which has been subjected to such conditions for 25 to 30 years or even longer.

As far as the writer is aware, little or no attention has yet been paid by the forester in Malaya to the regeneration of trees on "waste" land or soils similar to those on rubber estates of 25 to 30 years old, since this has not been necessary hitherto.

In the *Annual Report*, 1934, the writer referred to the situation in other countries in respect of soil deterioration due to bad agricultural practice and indicated that this is not only a parochial problem relating to Malaya but a world-wide problem which is only now receiving attention in many parts of the world, due to the belated realization of the enormous damage which has already taken place and which is continuing at an accelerated rate owing

to the increase in the world's population and the consequent rapid utilisation of land for various crops. It appears appropriate therefore to quote various statements made by leading authorities in other countries during the past year to supplement those published in the *Annual Report*, 1934.

In a lecture by L. O. Howard, the well-known American Entomologist, he states "Man is perhaps the most disturbing ecologic factor in the biological history of the world."

In a lecture entitled "Land and Land Use" by P. E. Brown, Head of the Department of Agronomy, Iowa Estate University, (*Science*, Vol. 83, No. 2854) the following observations are of interest:

"It takes 400-500 years to produce an inch of top soil which "may be lost in one year on a steep slope, in three years on a "moderate slope poorly managed or in one rainfall of the cloud-"burst type.

"China is a striking example of the misuse of land with con-"sequent erosion—due to having no land policy. The population "is now packed on a limited area of alluvial soil where floods "bring frequent disaster. China's decline as a nation is coincident "with loss of productive land.

"Land is not the heritage of one generation."

The following statements are extracted from an article entitled "Erosion in the Empire"—published in the *Queensland Agricultural Journal*, Vol. 45, No. 4, 1936.

"Today millions of acres of the Imperial domain all over the "world are in danger of destruction by the uncontrolled forces of "erosion. In many parts huge areas are losing their original "fertility; in others, immense tracts of once valuable land have "already reverted to desert, while many more are 'on the way'.

"The most simple and effective remedy includes preservation of "the soil's natural cover of trees and herbage; in short, by wise "and provident methods of agriculture. When the 'vegetational "balance' is upset there is literally no limit to the chain of evils "that result. The most expensive and (in some cases) the most "ineffectual are those involving the construction of huge dams "or weirs.

"It is now appreciated that the disappearance of certain "ancient civilisations is due to the conversion of what were once "fertile lands carrying a dense and highly civilised population, into "deserts, produced not by a change in climatic changes but by "man's ignorance and lack of foresight in his treatment of the "soil.

A valuable summary of the situation in the United States of America has been written recently by Dr. MacLagan Gorrie

of the Indian Forestry Service (Oxford Forestry Memoir No. 19. 1935, entitled "The Use and Misuse of Land.")

An interesting case is quoted in *American Hortigraphs and Agronomic Review*, Vol. VII, No. 1, 1936.

"On a farm opened in 1853 on which intensive cultivation has "been adopted since 1900, on account of economic pressure, the "land is now useless. The Head of the Soils Erosion Service "of the State states the saddest part of the story is that the dam- "age is so nearly permanent. Many years of soil building on the "part of nature with all the aid man can give, will be required "to restore these dissected fields to their former state of fertility. *"It is a very expensive process at the best."*

The following paragraphs quoted from Monthly Letter No. 55 issued by the Imperial Bureau of Soil Science are significant.

"History shows that individual man can do little to check soil "degeneration. Certainly each can try to maintain the maximum "fertility of his land, but if as usually happens he has thereby to "forego some immediate profit his more grasping neighbours will "get the better of him."

"A state planned agricultural policy can preserve or destroy "soil fertility in a way impossible under individualistic agriculture "..... Under rapacious capitalist cultivation the fertility is "decreased and subsequently the range and degree of influence of "the climate and soil properties is exaggerated.

The following extracts relating to the importance of the humus content of the soil are also significant.

The Journal of the Ministry of Agriculture (Great Britain) Vol. XLII, No. 11, February 1936, states:—

"There is surely no technical subject on which all classes of "cultivators are so closely in agreement as on the intimate relation- "ship between productivity and the supply of organic matter in "the soil.

"In the tropics, where the oxidation of organic matter takes "place most rapidly, the provision of humic material is often the "first step in land improvement. The more intensive the cultiv- "ation and the bigger the demands on the soil, the greater the "need for steps to maintain the content of organic matter".

In *Science*, Vol. 83, No. 2143, January 24th, 1936, a lecture entitled "The Conservation of our Land Resources" by Prof. J. G. Lipman, one of the leading agricultural scientists in America, contains the following statements:—

"Among the major constituents of the soil whose importance "we have under-estimated is the organic matter. It is not enough "that a soil contain the essential ingredients for the production "of plants. The soil must be able to absorb and to store suffi-

"cient quantities of water. Their texture and structure should "be such as to provide optimum conditions for the vertical and "horizontal movement of water and air. A good soil must "furnish a source of energy to various micro-organisms which are "a positive factor in crop production. Soil organic matter is a "source of food and energy for micro-organisms".

Cover Plants

Interest in the development and encouragement of natural cover plants has been maintained and a number of plants have been received for identification and for an opinion of their value.

In this connection there still appears to be some misconception in respect of what have been classified as Class III plants, such as bracken, stagmoss and Straits rhododendron. This is due to a confusion of ideas in regard to cause and effect. In the evolution of a new flora on a badly deteriorated soil, only certain plants will at first appear which are able to tolerate the poor conditions. The appearance of these Class III plants is therefore a symptom. In the first instance, until the soil improves or unless fertilisers are applied to accelerate improvement, these plants naturally compete with the main crop for the small amount of water and plant nutrients in such soils, so that the main crop shows still further signs of deterioration. It is therefore essential to keep such plants under control so that sooner or later, depending on the degree of impoverishment of the soil, plants graded as Class I or Class II may become established.

As has been indicated in the previous section, the rapidity of development of a better type of flora depends on various factors.

Although considerable study has been devoted to problems of plant ecology, there is at present no definite technique which can be recommended. Further the conditions vary enormously according to the extent of deterioration of the soil and the type of soil, *e.g.* on heavy coastal clay soils, with a high water table, no type of cover will have the same retarding effect on the growth of the main crop as on a badly-washed lighter soil on a slope. There are areas in certain parts of the country on which it will probably not be possible economically to regenerate the soil for rubber cultivation for 50 to 100 years or possibly longer. As Martin Leake states in a recent book entitled "*Unity, National and Imperial*" when referring to the early development of rubber plantations "land was land and rubber was rubber", i.e. rubber trees in a number of cases were planted on unsuitable soil.

In the development of leguminous covers under mature rubber trees, investigations have shown the necessity of manuring to

secure satisfactory growth. It is also recommended that the covers be grown in patches isolated by means of a shallow trench, in order to prevent in the first instance competition from the lateral roots of the trees. Unless this is done it is often difficult or impossible to establish cover plants under mature trees.

Our results at the Experiment Station have also indicated a considerable retarding effect of low-growing covers on the growth of the rubber tree. It should be stated, however, that this may not occur on heavy soils with a high water table.

On heavy soils, leguminous bush covers are generally recommended, while on hilly land low-growing ground covers are essential in the early stages and in replanting to prevent soil erosion.

A disturbing factor in some districts in relation to some of the leguminous bush covers is the incidence of Pink Disease (*Corticium salmonicolor*) which may spread to the rubber trees.

In several instances also low-growing covers and natural cover plants have been badly attacked by caterpillars while snails have caused damage in a few cases.

A new low-growing leguminous cover—*Desmodium ovalifolium*—may prove valuable on various types of soil. This plant is also known as Sengat Clover, as it was found originally on Sengat Estate, Perak.

At the Institute Experiment Station a series of experimental plots have been laid out for comparison of (a) indigenous cover plants controlled in several ways, (b) leguminous bush covers, (c) low-growing ground covers.

In each case, after felling the jungle, the felled timber was lightly burnt and the cover plants were grown on the banks of the terraces on which the rubber seedlings are planted. After only a light burn, indigenous covers develop rapidly. The felled timber is left on the ground between the terraces and is placed across the slope of the land in order to act as bunds to reduce erosion.

Manuring

Interest has been maintained in manuring and, apart from experimental trials, considerable manuring has been carried out under the auspices of the two firms which supply fertilizers in Malaya, each of which have agricultural advisory officers. It is gratifying to note that the advisory officers of these firms have kept in close touch with the Institute, so that useful collaboration has been effected.

The principal facts which have emerged to date are the delayed effect of fertiliser application on yields in the case of

"mature" trees, although reaction in respect of improvement in foliage is comparatively rapid. The response in respect of yield depends largely on the period during which deterioration has been taking place and the degree of impoverishment of the soil. An early indication of deterioration, which is exhibited before yields commence to drop, is a reduction in the rate of girth increase and in the rate of bark renewal of the tree.

In relation to application of fertilizers to planting holes when replanting, it is recommended that the fertilizer be mixed with the soil in the upper portion of the hole. If organic fertilizers are placed in the bottom of the planting hole, where the soil is comparatively sterile, decomposition and availability will be slow, while in the case also of fertilizers in which the constituents are "available" for the immediate needs of the plant, they are more readily accessible to the small lateral feeding roots of the seedling when mixed with the soil in the upper part of the planting hole.

As a result of a proposal submitted to the Institute by the Kuala Selangor District Planters' Association, a number of estates in that organization have offered areas for experimental work on the application of fertilzers to coastal clay soils and peat soil overlying clay. Arrangements have been made to inspect and select suitable areas, after which the design of the experiment and conditions will be submitted to the proprietors of the estates, so that the experiments can be commenced in 1936. (Note:—Several areas have since been selected and the estate owners have agreed to the conditions laid down by the Institute for the conduct of the experiment and the keeping of records. Experiments have therefore been commenced on these areas).

Hitherto little response to manures have been obtained on these types of soil, although no experiments have been carried out systematically over a period of years. In these experiments, a period of ten years has been laid down as a minimum.

It is of interest to note that the growth of budded rubber on replanted areas on the coastal clay soils has been excellent, which indicates a large reserve of plant food in the soil. Further, little or no erosion due to rainfall has occurred on these areas which are flat. The principal factors governing growth have been the depth of the peat layer on the peaty areas and the height of the water table. On many of these areas, after being under cultivation for 25-30 years, the peat layers have consolidated to form a comparatively thin surface layer of black crumbly soil.

Replanting

Further interest has been evinced in replanting, partly as a result of the concession allowed by the Controller of Rubber and

his Advisory Committee in respect of the deduction of allowance made for the mature trees which are removed for replanting, and partly on account of the realization by estate owners of the value of areas of new high-yielding material compared with a more or less rapid deterioration of the existing "mature" trees. An interesting and useful lecture on problems relating to replanting was given by Mr. A. Moore, Advisory Officer of the Institute, at the Annual Conference of the Incorporated Society of Planters held in Malacca. This lecture has been published in *The Planter* and in the Institute Journal (Vol. 6 No. 2) and also issued as a Reprint. In this lecture the economics of replanting vis-a-vis the manuring of old rubber trees are discussed and figures are given of the average cost of replanting. In regard to these figures, it must be borne in mind that there may be considerable variation on different sites, particularly in respect of the digging required for the eradication of root disease present in the existing stand of trees. The figure given for "upkeep to maturity" is also probably rather on the low side.

Although it does not appear probable that many small-holders will be able on account of financial reasons to replant, it is considered desirable to carry out experiments on rubber small-holdings. The principal factor which requires investigation is the minimum area which can be replanted successfully on account of (a) the effect of shade of surrounding mature trees (b) competition of the roots of the "mature" trees. From observations made on disease patches on large estates, it is realized that the growth of the young seedlings on such areas is affected principally by root competition from the surrounding "mature" trees and that isolation of such areas by trenches is essential for satisfactory growth. It must be borne in mind that during the operation of the present Rubber Regulation Scheme, only 10 per cent of any small-holding can be planted in any one year and only 20 per cent in toto. In view of the small area of many of these holdings (3-4 acres) the replantable area per holding is therefore small. Arrangements are in hand for the acquisition of suitable small-holdings' areas for carrying out replanting experiments and it is hoped to commence work in 1936.

Experimental Planting

The scheme for experimental planting to which reference is made under Botanical Investigations is of value in enabling the Soils Division of the Institute to carry out comparative investigations on soils of specific type, under virgin forest, and similar soils on particular estates which have been under cultivation for some years, and to follow up such investigations at intervals, in

order to ascertain the changes which occur in the soils as a result of cultivation of the rubber tree. Already (1936) a very useful survey has been made on soils of different geological origin, as a result of preliminary investigations on soil profiles obtained during the inspection of such areas.

These results are of value in our study for Malayan soils in relation to the cultivation of the rubber tree and indicate the deterioration which has taken place since the areas were planted.

It is anticipated that considerable progress in connection with soil investigations in relation to the requirements of the rubber tree will be effected during the next few years.

General

In writing this final report, however, I should like to emphasize the fact that we are now only beginning to realize the deterioration which has been in progress for some thirty years due to unsuitable agricultural practice in the past, particularly in respect of the effect of clean-weeding.

This deterioration has probably been of a "geometric" character, so that for years, the effect was not sufficiently rapid to act as a warning of our waste of capital in the form of surface soil, but has now become sufficiently accelerated to make us appreciate that steps must be taken both to prevent further losses of soil fertility of the land under cultivation and to adopt measures for improving the fertility of such deteriorated areas.

It cannot be stated with any certainty at present whether regeneration of such soils will be effected in one or in several decades, but we are in a position to realize to some extent the methods which must be applied. The rapidity of improvement is related both to economic factors *i.e.* the price of raw rubber in relation to the cost of fertilizers, and the increase of yields from a unit area by the planting of high yielding material—and to the degree of deterioration which has already taken place.

In a few areas it is probable that methods of improvement will be definitely uneconomic and the regeneration of soils on such areas can only be economically effected by nature over a period of many years. Fortunately, it is probable that the extent of such areas is not large.

Botanical Investigations

The research investigations of the Botanical Division, most of which are of a long range character have followed the lines previously laid down and approved, so that the report of the Division indicates the progress during the year of a large number

of field experiments both on the Institute Experiment Station and on various estates.

Importation of Planting Material

Owing to the restriction of export and import of all rubber planting material under the International Rubber Regulations Scheme no seed, budwood, stumps etc. have been imported. There is however ample planting material available in Malaya for replanting purposes and also new Malayan material for experimental purposes.

Vegetative Propagation (Budding)

Investigations in relation to budding technique has been concerned chiefly with the after-care of the stock. Several methods of treating the pruned surface of the stock have been tried. The method described in the previous Annual Report in which the pruned surface is coated with a mixture of cattle manure and clay which is covered by a piece of hessian (gunny sacking) has proved effective and economical. Studies have been continued on the growth of budded trees on the Institute Experiment Station, on certain estates and on replanted areas. The results are recorded in the report of the Botanical Division.

Except on coastal clay soils, it is essential to improve soil conditions by the application of fertilisers on all replanted areas.

Further records of the growth of budded plants (Clone A.V.R.O.S. 50) at different planting densities are recorded, which show a marked reduction in girth in the more densely planted areas (12 ft. × 12 ft. and 10 ft. × 10 ft.) at the age of 5 years. The increase in girth at the highest density was only just over half that at the lowest density.

Up to the age of 4 years the difference in girth at various planting densities was negligible. The effect of density of planting on girth will however probably vary for different clones.

No results are yet available in regard to the mutual relationship between stock and scion in buddings since the twin seedlings used for budding are still young.

No records are also yet available which indicate the value of any particular stock material, although generally scions budded on the more vigorous stock show the more vigorous growth.

Physiology in relation to Latex Production

All experimental work on tapping, tapping systems are included in this section, since the system of tapping is closely related to latex production.

The biochemical work involving a study of the composition of latex is discussed under "Chemical Investigations".

Very high yields have continued to be obtained from an area of old rubber trees (probably about 20 years old) on which an experiment on "V" versus half-spiral cuts is being conducted. On this area, the trees had not been tapped previous to 1933. The records from the series of tapping experiments on Seventh Mile Estate during the third year confirm the results previously published in the Institute Journal. In comparison with the control (A.D. System) the yields of the various A.B.C. and "Sunderland" systems have fallen below those of the second year, probably due to the fact that during the second year of tapping part of the tapping cuts in the control plots passed over the junction of virgin and renewed bark and these gave a depressed yield on the control plots.

On account of high bark consumption it has been found necessary to convert the Double-four system into an A.B.C.D. system, so that one section of the area is rested in rotation for four months, followed by tapping for 12 months. An experiment to determine the influence of bark consumption on yield was commenced at the Institute Experiment Station. Early records for the first year show no significant differences between yields for bark consumption of $\frac{3}{4}$, 1 in. and $1\frac{1}{4}$ ins. per month. The experiment is still in progress.

Various tapping experiments are also being carried out on the rows of boundary trees in the Manurial plot (Block 6) at the Experiment Station with seedling trees and on the Clone Trial Plot (Block 5) on budded trees.

Tapping has been continued on the clones on Pilmoor Estate. There has been a reduction in both girth increase and yield of these clones compared with the previous year.

The advantage of daily tapping in alternate months over alternate-daily tapping has not been maintained except in the case of Pilmoor Clone D. 61.

Experiments on high and low tapping cuts on budded trees show a relatively small decrease in yield for the higher tapping cut compared with the considerable decrease in the case of seedling trees.

The records of other tapping experiments are given in the report of the Botanical Division. Many of these however require to be continued for a long period before definite conclusions can be stated.

Anatomical Investigations

The results of Mr. Gunnery's investigations on the anatomy of sieve tubes and latex vessels in relation to yield of latex were pub-

lished in the Institute Journal. Owing to his resignation this work has been temporarily discontinued on account of lack of staff—it will however be resumed and extended.

Selection and Breeding

Work on new clones at the Institute Experiment Station was confined to maintenance and observations on growth; fifteen new estate clones were established at the Station for comparison with a standard clone.

No extension of the work on artificial pollination has been made but tapping has been carried out on the seedlings planted in 1928-29 from the artificial crosses of various Pilmoor estate clones.

The results confirm the previous test-tapping records and show the high yields of families in which Pilmoor A44 is one of the parents. One cross (B84×A44) is outstanding. The highest yielding tree (Family D61×A44. Tree 209/3) yielded 17.8 lbs. of dry rubber during the year, the age at commencement of tapping being 5⅔ years.

As would be anticipated there is a considerable variation in yield, as in the case of ordinary seedling material, compared with budded trees.

The records from a second series of seedlings from artificial pollinations planted in 1929-1930, which have just come into tapping, also confirm the high yielding capacity of families with Pilmoor A44 or B84 as a parent.

Preliminary records are given in the Botanical Division report of the yields from buddings obtained at an early age from these seedling crosses by disbudding. Insufficient trees of a tappable size are however as yet available for an analysis of the records.

Records of yields of illegitimate or clonal seed from high yielding clones are given in Table XVIII in the Report of the Botanical Division. The chances of pollination by inferior clones or surrounding ordinary seedling trees were considerable. The yields obtained, although superior to those from ordinary unselected seedling material are lower than those from seedlings derived from hand pollinations between high-yielding clones.

As has been emphasized previously, in producing a family of illegitimate seedlings a number of parents may have produced the pollen and the range of variation in such seedlings is greater than that of "legitimate" seedlings. The figures recorded, including the coefficient of variability, indicate the risks taken in planting "illegitimate" clonal seed.

Test-Tappings for Selection

Further records are given in Table XXI in the Report of the Botanical Division of the correlation between yields obtained by

early test-tapping and subsequent yields from normal tapping. The results obtained show a high degree of correlation except for the A.D. system at the youngest age (3¼ years). The correlation is not more reliable when the trees are over 4 years old. The results are of value in relation to yield records from test-tapping for thinning out.

The early records of test-tapping of clonal seedlings selected in the nursery by using Cramer's knife show considerable differences between clones, the best results being obtained in the case of Clone Pilmoor A44.

In the case of two types of seedlings no differences are recorded between the three classes into which the seedlings had been divided. There is also considerable variation in individual trees in each class.

Natural Cover Plants (Ecological Studies)

A study of natural cover plants on Block No. 27 at the Institute Experiment Station is being made.

On this Block various treatments in respect of natural covers are being compared with plots on which bush or low-growing leguminous covers have been planted.

Preliminary observations show the large number of indigenous species (90) already identified and indicate the large amount of work necessary for the ecological study involved. It is also extremely probable that these species will vary considerably on different soil types.

It will be necessary to continue this study for a number of years before any definite conclusions can be drawn which may be of value in actual estate practice.

As has been emphasized in a previous section and elsewhere in a discussion of this problem in relation to soil improvement no scientific technique is available and the advice of the world's leading plant ecologists or foresters would be of no practical value, since ecological problems in relation to waste lands or areas deteriorated by bad agricultural practice have only been studied hitherto on a broad and general basis in respect of particular sites.

It may however be essential for Governments in various parts of the Empire and elsewhere to consider the necessary of attaching botanists to existing agricultural or forestry departments in order to study methods for the reclamation of waste or deteriorated areas, since natural methods of preventing further erosion and improving such areas will be more effective and economical than mechanical methods devised by engineers, although the latter may be useful at the start in certain circumstances.

This suggestion has already been advanced in other countries. Fortunately on most areas in the tropical rain belt helio indigenous plants develop fairly rapidly, although in some countries, as in Malaya, control is essential to prevent such areas from being monopolised by some dominant plant such as lalang grass (*Imperata arundinacea*) the growth of which will exclude for many years other more desirable types.

Experimental Planting

Under the International Rubber Regulation Scheme each country in the scheme is allowed to plant for experimental purposes one quarter of one per cent. of its planted area when the scheme was inaugurated.

The purpose of this concession is primarily to enable experimental work, initiated before the Regulation Scheme was inaugurated, to be continued for the general benefit of all producers in the country and not for the sole benefit of any individual estate.

The principal object is the testing of new planting material while subsidiary objects are the opening up of new land under different methods, followed by the development of various natural or leguminous cover plants and in some cases the application of fertilizers from the commencement of planting. Such planting can, of course, only be carried out by estates which have reserve areas.

The total area allocated has been distributed among the various administrations according to the planted areas.

As a result of representations made by the Institute, the Controller of Rubber, Malaya, has agreed to approve areas in accordance with the recommendations of the Institute and a form of agreement is being drawn up, binding the estate concerned to carry out the experimental work in accordance with the design or lay-out and other conditions required by the Institute for a minimum period of ten years. All records from the experimental areas must be available to the Institute which agrees to pay any extra cost involved in the keeping of records. The Institute has the right to publish all results for the benefit of the industry as a whole.

Owing to the large number of applications and the fact that the areas applied for considerably exceed the total area allocated to the country under the scheme, it has been necessary to divide the applications into categories, depending on various factors, such as the suitability of the site and soil, the supervision available etc.

In every case, therefore, a preliminary inspection and examination of the land is made by an Officer of the Soils Division of the Institute before any recommendations are made to the Controller of Rubber.

This scheme will be of considerable value as an extension throughout the country of the experimental work in progress on the Institute Experiment Station. It will enable valuable observations to be made in many directions on new planting material under different conditions and types of soil.

Advisory Work and General

The advisory work of the Botanical Division has increased considerably during the year. This is inevitable in view of the number of problems requiring investigation and has to be realized by all. Much of the work of the Division is concerned with field experiments on various types of planting material and it is essential that the Botanical officers should keep in close touch with planting practice which means, as in other cases, that advisory work cannot be divorced or isolated from research problems. Many individual problems on particular estates which are referred for advice are of value in relation to investigations in progress.

Diseases and Pests

There is no new outstanding factor to report during the year so that investigations have been confined to diseases and pests which are already known.

Owing to the absence of Mr. Napper during the whole year, investigations on root diseases were suspended but much advice was given and numerous visits paid to estates in connection with root diseases, particularly in relation to replanting.

The various diseases and pests of the rubber tree will be discussed as in previous years under the following headings: (a) root diseases (b) diseases of the tapping panel (c) stem and branch diseases (d) leaf diseases (e) insect and animal pests.

Root Diseases

Although there is nothing new to record during the year, all observations made confirm previous work and recommendations for the treatment of the three principal root diseases (*Fomes lignosus*, *Ganoderma pseudoferreum* and *Fomes noxius*).

It is gratifying to record the interest which is now being taken in methods for the eradication of root disease.

Special attention is directed to the replanting of peaty areas. Two instances have occurred in which root disease appeared to be dormant or non-existent, but a virulent attack was experienced later in replanted areas, after lowering the water table, due to lateral roots and undecomposed jungle wood left in the soil.

The extent of root disease in the existing stand of "mature" seedling trees constitutes one of the most important items in the cost of replanting.

In many old areas, on which the diseased patches have coalesced, due to non-treatment or incorrect treatment in the past, it is essential to dig over the whole area in order to avoid the risk of infection of the new planting material.

Reference might here be made to the fungus *Ustulina zonata* which is often responsible for the death of a number of trees. Since this disease is not spread by means of rhizomorphs on the lateral roots but by spores only, considerable saving of expenditure on digging can be effected during replanting if this disease is known to have been the cause of death of the old trees.

Diseases of the Tapping Panel

Mouldy Rot (*Ceratostomella fimbriata*).

There has been a considerable reduction in the incidence and virulence of Mouldy Rot disease of the tapping panel on smallholdings, especially during the rainy weather of the last quarter of the year. This is due to the sale of coupons by many smallholders and the consequent cessation of tapping.

There have been no changes in methods of treatment and no new fungicide has been added to the approved list.

Other Diseases

Reference is made in the Report of the Pathological Division to Brown Bast, Black Stripe and Patch Canker (*Phytophthora* sp.) and White Fan Blight (*Marasmius* sp.) as well as to an unknown canker encountered on a few budded trees at the Institute Experiment Station. In no case, however, have any of these affections been widespread or virulent.

Stem and Branch Diseases

Pink Disease (*Corticium salmonicolor*)

Pink disease has caused trouble in a few districts and alarm has been expressed at its appearance on certain leguminous bush covers e.g. *Crotalaria* sp. In certain districts the use of such covers is being discarded on account of the probability of the spread of the disease to the rubber trees. In this connection, it should be noted that no cover plants should be planted too thickly or too close to young rubber trees.

Leaf Diseases

(a) *Oidium Heveae* (Leaf Mildew)

It is satisfactory to record that the incidence and virulence of *Oidium Heveae* during the refoliation period after "wintering" was comparatively mild. The disease attacked only the 20-25 per cent of late "wintering" trees and then generally only in a mild form. Foliage and seed setting has been considerably better than during recent years.

The incidence and virulence of the disease is in accord with opinions expressed previously by the Institute on the effect of climatic conditions on the fungus and on the host plant.

As a consequence of the satisfactory situation, very little sulphur-dusting was carried out, so that no records of any improvements due to treatment are available.

(b) *Hevea Thrips*

An insect of the Thrips species was found to cause considerable leaf-fall resembling that caused by *Oidium Heveae*. In several instances areas of trees which wintered and refoliated simultaneously were heavily attacked.

The climatic conditions favourable to an outbreak of *Oidium Heveae* also appear to favour attack by this insect. This corresponds with experience in other countries in relation to Thrips sp. on other plants. The insect can be controlled by sulphur-dusting.

(c) *Spiders and Mites*

The small red spider (*Arachnid* sp.) and Mites have also been responsible for secondary leaf-fall in some districts.

(d) *General*

A full report of the mild attack of *Oidium Heveae* during 1935 and an article on Thrips have already been published in the Institute Journal.

Insect and Animal Pests

The insects—Thrips, Spiders and Mites—have been commented on in the previous section, on account of the fact that the leaf-fall caused by these insects closely resembles that caused by the Mildew fungus—*Oidium Heveae*.

(a) White Ants (*Coptotermes curvignathus*)

White Ants still continue to attack rubber trees on a number of estates. Although no absolute method of destruction has been

discovered the application of fumigants and poison dusts in combination is increasing in favour and gves a fair degree of control, if properly carried out.

(b) Cockchafer Grub (*Psilopholis grandis*)

The cockchafer grub has been reported from six new widely scattered areas.

No serious damage to rubber trees has been reported, but natural covers have been destroyed by the grubs feeding on the roots of the plants.

The original areas on which the grubs were found do not appear to have become enlarged.

(Note:- Correspondence has recently been exchanged with the Proefstation West Java in connection with a similar infestation on certain estates in Java).

No economic method of eradication has been discovered. Further experiments carried out by local firms interested in the sale of insecticides have failed to effect control by treatment of the infested soil areas with chemicals.

(c) Caterpillars

Caterpillars have been responsible for the partial destruction of natural and leguminous cover plants on several areas. A bad attack occurred on the newly opened area (Block 27) on the Institute Experiment Station. If observed in time, control can be effected by spraying with lead-arsenate. Fortunately the cover plants at the Experiment Station recovered from the attack, although fairly complete defoliation was caused.

Several species of hairy caterpillars also cause irritating wounds on the legs of labourers.

(d) Snails and Slugs

The giant snail has been reported to have caused damage to young rubber plants, but more frequently a small slug has been found to eat the plants. No completely satisfactory method of chemical control by poisoning has been discovered.

(e) Rodents

Rats, squirrels and porcupines have been reported occasionally to cause damage, especially to young plants. Rats in particular will often eat newly planted rubber seeds. This is particularly serious in the case of expensive clonal seed. In some cases poison baits have proved ineffective and the only satisfactory method of protecting young rubber seedlings in the field is to encircle the plants with a cylinder of wire netting.

Bacteriology of Latex

Although the investigation of the bacteriology of latex does not properly come under the heading of Diseases and Pests, reference to the work is made here, since Mr. Beeley has been carrying out work in collaboration with the Chemical Division in relation to preservatives for latex.

So far no suitable substitute for ammonia for the preservation of latex for shipment has been found, although a number of powerful bactericides have been investigated.

A few, however, are effective in the presence of ammonia and enable smaller amounts of ammonia to be used as a preservative of latex. If cost is considered, however, ammonia still continues to be the most satisfactory preservative.

Bacteriology of Soils

Bacteriological investigations on soils also do not properly come under the heading of Diseases and Pests, but again reference is made here, since certain investigations are being made by Mr. Beeley on experimental areas on several estates on which fertilizers have been applied and on which natural cover plants are being encouraged to effect soil improvement. Chemical analysis is not usually of much value in indicating gradual improvements effected in soils by the application of fertilizers or the growing of cover plants.

The object of the present investigations is to determine whether improvements can be indicated by periodic counts of the soil micro-organisms.

The influence of the medium employed for the development of bacterial and fungal colonies is of considerable importance, as is indicated in the preliminary investigations.

Chemical Investigations

As in other Divisions, research investigations have been curtailed during the greater part of the year by shortage of staff, owing to leave exigencies and losses.

Research on Latex Constituents

During the last five months of the year, research on latex constituents, which had been in abeyance since the previous year, was re-commenced by Dr. Roberts and considerable progress was made by means of a new technique developed by him for the

isolation and characterisation of various constituents from "whole" rubber prepared by the evaporation of thin layers of latex.

This work is of the greatest importance in relation to (a) the fundamental problem of the physiology of latex production (b) the influence of various constituents on the properties of raw rubber and latex for manufacturing purposes (c) seasonal variations in latex and (d) possible variations in clonal latex.

As has been mentioned previously, the Rubber Growers' Association proposes to carry out investigations on different latices at home and it is very desirable to have collaboration in relation to this work. Correspondence has been addressed to the Association on this matter.

Latex Preservation and Shipment

Further experiments and experience have indicated the desirability of increasing the ammonia content of preserved latex for shipment to 0.70—0.75 per cent, since 0.5 per cent is considered the minimum and may be too low in many cases. The larger amount is now being used by Malayan estates which export latex.

Experiments have been carried out with various bactericidal and fungicidal chemicals and proprietary products, to ascertain whether any suitable product can be used either as a substitute for ammonia or in admixture with ammonia in order to reduce the amount of the latter.

Although certain mercury compounds have proved satisfactory particularly mercury cyanide—it is considered that this substance is too toxic for general use and can only be used when its toxic properties are not considered important for the purpose to which the latex is to be applied. Several powerful proprietary bactericides have been found to be ineffective in the presence of latex.

In relation to the discolouration of latex, proved in our laboratories to be due to contamination with iron—principally derived from the shipping containers (steel drums)—latex-cum zinc oxide filming of the interior of drums has been used extensively and successfully by one large producer. Attention however has been drawn to the effect on the stability of the latex, due to the possibility of zinc oxide (ammonium zincate) from the film being dissolved in the latex.

A Singapore firm, on whose behalf experiments have been carried out in our laboratories on filming materials, now markets suitable latex drums which have been treated internally before assembly.

Investigations are in progress with the object of fixing a standard for colour. Such standards are being prepared at home by collaboration of the London Advisory Committee, The Rubber

Growers' Association and the Rubber Trade Association and will be sent to the Institute when ready.

When latex is not properly preserved, putrefactive odours develop, due to the decomposition of some of the non-caoutchouc constituents of the latex. These odours are also associated with changes in the latex affecting its stability, aggregation of caoutchouc globules and other properties. In spite of experimental work, no simple chemical test has yet been discovered for determining the degree of putrefactive odour.

An important property of preserved latex for many purposes is its stability. No standard test for determining degree of stability has yet been adopted. Investigations however are in progress to determine the factors affecting stability and to develop a standard technique.

Viscosity and surface tension determinations have been continued, in order to ascertain the correlation between these properties and the various constituents of the latex.

The industrial demand for preserved latex has been maintained during the year, although the increase in consumption is not as great as some leading producers had hoped.

Consumers are becoming more exacting in their requirements and the necessity of certain specifications in respect of quality has become evident.

Although it is probable that some of the proposed specifications or standards are likely to be adopted in the near future, others require further investigation before they can be accepted or assumed to be essential. The adoption of such specifications and requirements of consumers indicate the necessity for large scale bulking equipment on any individual estate or the grouping of estates for export of latex of uniform quality.

Latex Concentration

For many purposes, the use of some type of concentrated latex is indicated, so that the export of concentrated latex in relation to that of ordinary field latex is likely to increase.

Large quantities of centrifugal concentrates are being prepared and exported by one large planting company. It is believed that the whole crop is being exported either as preserved latex or contrifugal concentrate.

One or two estates are also shipping creamed latex. Investigations are being continued at the Institute on (a) concentration by centrifuging (b) concentration by creaming and (c) concentration by evaporation.

In each case various factors which may affect the rapidity and the efficiency of the processes in relation to the maximum dry rubber content of the concentrates are being investigated.

A special centrifuge obtained by the Institute through the London Advisory Committee has been tested but has been found to have various defects, which render its adoption for commercial purposes of no value although useful for experimental work in the investigations of factors or methods of treatment for improving the efficiency of the centrifugal process of concentration.

It is of interest to note that, in the concentration of latex by centrifuging or by creaming, it is desirable to experiment with freshly preserved (ammoniated) latex, since results obtained at home with preserved latex which has been stored cannot be obtained with the freshly ammoniated latex which would be normally used on estates.

Investigations have been continued on the process of concentration by creaming with various creaming agents and methods of treatment for increasing the efficiency of the creaming process. Tragon seed A (Carob seed) gum has been found more reliable than gum tragacanth. Storage of the ammoniated latex for six weeks before creaming has been found to give the maximum dry rubber content.

Experiments have been carried out with various hemicellulose and methylated carbohydrates received from the London Advisory Committee laboratories. A few of these are promising but none are more efficient than Tragon A Gum used by us as a standard. Further, the cost of these materials is at present not known and no "standard" preparations are available on the market.

Two patents have been taken out in Great Britain by the Institute in relation to creaming processes.

In this connection, it may be recorded that several "improvement" patents for increasing the efficiency of creaming, which have been taken out in various countries by other investigators, appear to lack essential novelty and are obvious methods which would be adopted by any person versed in the art.

Arrangements are being made for experiments to be carried out in our laboratories for testing of apparatus designed in the London Advisory Committee laboratories for concentration of latex by evaporation; this plant however was not ready at the end of the year. The Revertex process of concentration by evaporation continues in operation on two estates in Malaya.

Clonal Latex and Rubber

Owing to the death of Dr. Wiltshire at the end of 1934 investigations on clonal latex were in abeyance. As mentioned previously, this work will be continued by Dr. Roberts on the basis of the technique developed by him for the separation of latex constituents. Investigations however have been continued on rate of cure, plasticity and ageing properties of the rubber from certain Pilmoor Estate clones. Differences in rate of cure of two of these clones, referred to in previous reports, have persisted during the present year, as have also seasonal variations affecting all the clones, especially after wintering.

This work will in future be continued with clonal latex now available on our Experiment Station.

Coagulants

Formic acid continues to be the chief coagulant used on large estates and its use is extending on small-holdings.

One or two estates continue to use sulphuric acid but its use is decreasing on both estates and small-holdings, as a result of propaganda and advice from the Institute.

A full report on coagulants used on small-holdings will be published during 1936 in the Institute Journal (see Vol. 7 No. 1). The services of the Rubber Instructors of the Small-Holders' Advisory Service have been extremely valuable in enabling us to make a survey of the coagulants used on these holdings.

The sodium silico-fluoride cum magnesium sulphate or chloride solution for the coagulation of alkaline (ammoniated) latex has been used successfully by one or two producers for preparing sheet or crepe rubber from stocks of old unsaleable preserved latex. It may be pointed out here that this process is only intended for the treatment of occasional consignments of latex of this nature and not as a general method of coagulation.

Contamination of Latex with Copper

The work referred to in the previous Annual Report on the possible contamination of latex and raw rubber with copper, due principally to the use of brass sieves for straining latex, has been continued. A report on these investigations is being published in the Institute Journal (Vol. 7 No. 1, 1936). The particular danger of straining ammoniated latex through brass gauze sieves, owing to the solubility of copper in ammonia, has been emphasized. Producers have been advised to use Monel metal or nickel gauze sieves.

It is interesting to note that the presence of traces of copper in normal latex, reported by previous investigators, has been confirmed.

Another interesting fact is that although, after a considerable storage period of six to eight months, there may be no indication of softness or tackiness in the raw rubber (sheet) due to minute traces of copper, the ageing quality of such rubber after vulcanization is poor.

Sheet Rubber

Although no statistics are available, the preparation of first grade pale crepe rubber on estates appears to be decreasing. This is due chiefly to the use of latex in the manufacture of numerous articles for which thin pale crepe was formerly employed.

The preparation of smoked sheet rubber, with modern equipment in the form of line-ahead sheeting machines and with flooding or other methods for conveying the coagulum from the coagulating tanks to the battery, is the most economical method of preparation of raw rubber. It is extremely improbable, even if some form of crumb or powdered rubber is eventually prepared on a number of estates, that this form of rubber can be made as cheaply as sheet rubber, as is claimed by one of the companies interested in the development of crumb rubber.

The line-ahead sheeting batteries, now manufactured by a number of engineering firms have become the standard equipment on all up-to-date large estates.

The " Subur " type of smoke house of one storey with trolley equipment for smoking and drying racks is being adopted on a number of estates requiring new smoke houses.

In the case of estates on which the water-table is high a type with an above-ground furnace and flue has been designed. Since, in this and other modern types of smoke houses, the more rapid and economic drying and smoking of sheet rubber in a period of four to five days results in a lighter-coloured rubber, investigations are in progress on the properties of light and dark coloured smoked sheet rubber and hot-air dried sheet rubber. Complaints have been made by consumers that light-coloured sheet is inferior to dark-coloured sheet in respect of its plasticity and ageing properties.

Our experiments have shown that hot-air dried sheet has poorer ageing qualities than smoked sheet, as has also the sheet prepared in certain types of smoke houses with extremely rapid drying at a temperature above 140° F. and only a short period of smoking. This investigation is being continued with the object of determining the factors involved.

Drying trials have also been carried out in a special chamber erected at the Institute Experiment Station with oil-burner equipment loaned by the Asiatic Petroleum Co.

The object of these trials is to ascertain whether such fuel in a properly controlled drying chamber is as economical as the use of wood fuel, which is becoming scarce on a number of estates. This installation will also enable us to carry out useful controlled drying experiments.

Reference has previously been made to the Small-Holders smoke house which can be constructed of (a) hessian (b) split bamboo walls lined with paper (c) split areca palm stems with a covering of areca palm or other spathes (d) cheap wood.

The Circular issued by the Chemical Division on the lay-out of estate factories and construction of smoke houses appears to be much appreciated and it is of interest to note that the Institute is invariably consulted in connection with new factory buildings and smoke houses erected on practically all estates.

Modified Rubbers

Reference was made in the previous Report to work in relation to modified rubbers.

Experiments have been continued on the preparation of raw rubber having low water-absorption properties, required particularly for electrical insulation purposes. Certain types have been prepared and a consignment has been sent home for tests to be carried out by cable manufacturing firms and for investigations by the Research Association of British Rubber Manufacturers.

The preparation of such rubber however and its utilization will depend largely on its cost. It is interesting to note that one of the large cable companies in the U.S.A. now uses for cable insulation a triple-creamed latex having low water-absorption properties.

Soft Rubbers

Plasticity tests have been carried out on a large number of samples of air-dried and smoked sheet with the object of determining the causes of variability in plasticity, primarily with the object of avoiding the production of a tough product which is undesirable for manufacturing purposes, owing to the difficulty and extra cost of "breaking down" on the masticating rolls.

Samples to which traces of copper and cobalt salts have been added were prepared and despatched to the Consulting Chemists of the Rubber Growers' Association both in relation to softening and in connection with researches on the "resinification" of rubber for paint manufacture.

Crumb Rubber

Samples of crumb rubber have been examined for "massing".

A new type of "crumb" rubber prepared by a special coagulation process is being experimented with in Malaya. If this proves successful, it should be a more economical process to operate than the various processes of spray-drying by which one or more of the present forms of powdered or crumb rubber are prepared.

General

In connection with work on modified rubbers and rubber derivatives, attention is directed to the Appendix to the Report of the London Advisory Committee prepared by the Superintendent of Rubber Investigations of the London Advisory Committee laboratories, in which details are given of investigations being carried out on behalf of both Ceylon and Malaya, in which this Institute is collaborating.

Rubber Roadways Research

Apart from the investigations on rubber-capped blocks for roadways, work on the application of latex for roadway surfacing and the use of crumb rubber or latex in conjunction with asphalt and also latex cum cement is being carried out in the London Advisory Committee laboratories.

As stated in the previous Report the investigations on latex mixtures for roadways are being financed by funds (£1,000 per annum for three years) provided by the Institute. Two officers have been engaged to work in the London Advisory Committee laboratories on this problem and reports are sent periodically to Malaya.

The first interim report describes technique developed for the examination of the structure of latex-cement mixtures, the effect of various colloids used for the stabilization of latex on the setting, hardening and tensile strength of aluminous cement, and the effect of compounding ingredients on the tensile strength of dried latex.

It is of interest to note that certain experiments carried out to incorporate rubber crumb with asphalt have proved very promising and one of the large asphalt companies have collaborated with the London Advisory Committee laboratories in laying a stretch of road.

Whilst it is not claimed that the use of a small proportion of rubber or latex, incorporated with asphalt or bitumen as a road surfacing material, constitutes a resilient "rubber" roadway suitable for reducing vibration and noise, the use of even 5 per cent of rubber in such a road-surfacing material, if found to

improve the wearing qualities and other properties of the mixture, would absorb an enormous amount of rubber *in toto*.

As soon as any useful information is obtained from the investigations in progress, the results will be published in the Institute Journal. It is considered however that no good purpose will be served at present by publishing the Interim Reports of Progress.

In regard to the sections of road laid locally with rubber-surfacing materials, the Cowling latex cum cement mixture laid down in 1933 on Victory Avenue, adjacent to the Chartered Bank, in Kuala Lumpur, has shown numerous signs of deterioration, holes being developed due to disintegration and consequent detachment from the foundations (Note: This section of roadway has since been removed by the Public Works Department).

One half of the section laid down by the Institute about the same time at the 4½ mile Kuala Lumpur—Klang Road has also had to be removed, owing chiefly, it is believed, to the deterioration of the concrete foundation. The other half of the road appears to be still in good condition.

Experiment Station.

The progress made on the Experiment Station is given in the Report of the Manager.

Commercial tapping was commenced during the year on certain plots, while various experimental systems of tapping have been started on boundary rows of trees, where such boundary rows constitute a guard row not included in the particular experiment.

Apart from the new plantings on the area of undulating land acquired in exchange for flat land in the old reserve, the most important items of interest are the following:—

(a) In the Manurial Experiment on Block 6, a significant increase in yield over all other plots is indicated on the plots treated with a complete inorganic fertilizer.

None of the other treatments, during this first year of tapping indicate any significant increases over the control plot.

(b) In the Natural Undergrowth (Block 11) there was a very marked improvement in girth after rentising.

(c) The insect—Thrips—caused considerable defoliation on late wintering trees *e.g.* Clones AVROS 50 in Block 6. *Oidium Heveae* was mild and attacked only the late wintering trees.

(d) A commencement was made with the erection of a factory, crepe-drying shed and packing room.

While normally smoked sheet will be the principal type of rubber prepared, it has been found necessary to instal creping machinery to treat the cup coagulum from hundreds of trees from which individual yields are being recorded.

(e) A series of trials has been carried out by the Chemical Division in collaboration with officers of the Asiatic Petroleum Coy. on the drying of sheet rubber by using the products of combustion from an oil burner.

Sheet rubber has been completely dried within 48 hours. It is interesting to note the greatly increased time of drying (50 to 100 per cent) in the case of sheets on which the estate name is impressed by using too deeply-cut letters, causing excessive thickness of the coagulum.

Agricultural Shows (Malaya)

Owing to lack of staff it was not possible to stage a comprehensive exhibit at the twelfth Exhibition of the Malayan Agri-Horticultural Association held in Kuala Lumpur.

A type of smoke house suitable for small holders was staged at this Exhibition and at various Districts Agricultural Shows and attracted considerable attention. (Note:—As a result of this propaganda, a large number of these smoke houses have since been erected by small-holders throughout the country.)

In addition the Chemical Division was responsible for arranging and staging the smoked and unsmoked sheet rubber for the All-Malaya Small-holders' rubber competition.

Lectures and Conferences

Lectures

The following lectures were delivered by members of the staff:—

Subject	*Venue*	*Lecturer*
Research and the Rubber Industry	I.S.P. Annual Conference	B. J. Eaton
Latex and Raw Rubber in The United States of America	—do—	E. Rhodes
Replanting	—do—	A. Moore
Recent Progress in the Selection of Planting Material of Hevea	I. S. P. Rantau-Port Dickson Branch	C. E. T. Mann
Research and the Rubber Industry	—do—	B. J. Eaton

Subject	*Venue*	*Lecturer*
Recent Research activities of The Rubber Research Institute of Malaya	I.S.P. Bahau Branch	B. J. Eaton
Factory Methods, present and potential	Central Pahang Planters' Association	—do—
Some Improvements in Smoked Sheet Manufacture	—do—	A. Moore
Diseases of Hevea: in relation to	Malacca Planters' Association	F. Beeley

CONFERENCES AND VISITS

Dr. Edgar Rhodes, Senior Officer of the Chemical Division presented a paper entitled "Raw Rubber and Latex" before the Rubber Division of the American Chemical Society in New York City on April 23, 1935.

At the request of the Editor of the *India Rubber Journal* an article entitled "Research problems of the Plantation Rubber Industry" was contributed by the Director.

Mr. C. E. T. Mann, Senior Officer, Botanical Division, attended the Imperial Botanical Conference held in London in August and the International Botanical Congress held in Holland in September.

Mr. Akhurst represented the Institute and Malaya at the Third Congress of the International Society of Soil Science held at Oxford.

Mr. Moore paid a number of visits to rubber manufacturers in Great Britain and the U.S.A.

Publications and Library

The publications issued during the year include the following:—

(i) *Journal* Vol. 6. No. 1.
„ „ No. 2.

(ii) *Annual Report 1934.*

(iii) a. Circulars relating to Pests and Diseases of the rubber tree.

b. Factory and smoke house designs and layouts. The card index of all important agricultural and rubber problems has been maintained. It is gratifying to note the demand of our publications from planters and others in other countries particularly Netherlands India and Ceylon.

Visitors

An increasing number of planters and directors of rubber companies have visited the Institute and the Experiment Station during the year.

Various branches of the Incorporated Society of Planters Malaya have paid special visits to both the Institute and Experiment Station.

A short course of instruction at the Institute and the Experiment Station was held for Penghulus in addition to the course held for the new Rubber Instructors.

Special visitors include the following:—

Mr. James Hair, (Cooper McDougall Robertson Ltd., England), Mr. J. S. Vollema, (Proefstation West Java, Buitenzorg), Mr. Stuart Gillet (Department of Agriculture, Kenya Colony), Mr. D. I. Lochner (I. G. Fabenindustrie, Frankfurt-on-Main, Germany), Dr. McIndore (Firestone Plantations Co., Liberia), Mr. W. E. Cake (H. A. P. M. Kisaran), Mr. T. Koizumi (Consolidated Sango Koshi Ltd., Japan), Mr. H. J. Walmesley (Malayalam Plantations Ltd., S. India), Mr. Graeme Batten and Party (British Medical Association, London) Dr. H. N. Whitford (Rubber Manufacturers Association, New York), Mr. Thomas Guthrie (Chillington Tool Co., Wolverhampton, England), Sir F. M. Voules, (Chairman, Kepong (Malay) Rubber Estates Ltd. London), Luang Vichien Dhatukarn (Department of Science, Bangkok), Mr. J. E. Barrs (Newton Chambers & Co., Ltd., Sheffield), Mr. S. Shiraishi (Nishi Butecho, Osaka, Japan), Mr. T. Takeshita (Govt. Sugar Experiment Station, Tainan, Formosa), Mr. R. Wauters, Medan (Societe Financiere des Caoutchoues, Medan), Mr. M. G. Canlas (South Siam Agriclt Expt. Station, Haadjai), Luang Thavil and Party of 16 Siamese Officials—delegates of Oriental Tourist Conference to Japan from Siam, Dr. P. J. S. Graner (Holland), Mr. I. L. Cameron (Colombo), Mr. R. B. Willmott (H. M. Trade Commissioner, Singapore), Mr. W. Menzies (Babcock & Wilcox Ltd., London.)

General

In writing this last report, I wish to pay a special tribute to my colleagues in the Institute. Numbers of letters have been received testifying to the excellent work being carried out at the Institute—some of these being from similar and other organizations outside Malaya. During the year under review, as is indicated in the reports of the Divisions, the situation has been extremely difficult, owing to previous retrenchment and leave exi-

gencies. It is gratifying but embarrassing to note the increasing extent to which the advice of the Institute is sought, not only by estate managers but also by Boards of Directors who request their managers to refer matters relating to planting to the Institute.

My thanks are also due to numerous managers without whose willing co-operation, progress in certain directions would not have been so rapid.

I wish also to take this opportunity of paying a tribute to the clerical staff and junior laboratory staff, both at the Institute and the Experiment Station. Their loyal support and their efficiency in carrying out their duties is of the greatest importance to the research staff.

The new buildings which were started just before the close of the year should prove a fitting home for the important work of the Institute.

At the close of just over 30 years' agricultural and chemical service in Malaya, the last one-third of which has been spent in the Institute, I take this opportunity of wishing the best of luck to my colleagues in their future work on behalf of the rubber industry, and also numerous planter friends for their future welfare and that of the important industry on behalf of which they as producers and we as technical advisers and research workers are co-operating.

The industry at the present time has reached a stage at which progress will depend more and more on the application of the results of scientific research and it is gratifying to note that never in the history of the rubber planting industry, with which I have been connected in Malaya since its infancy, have the scientific advisers and research officers been called upon to such an extent as during the last two years.

B. J. Eaton

Director

APPENDIX

Botanical Division

Analysis of Correspondence 1935

	Subject	Letters received	Letters despatched
I. Budding.	General. Advice on choice of clones. Clone Records	232	240
,,	Training of Conductors and Pupils from Estates, etc.	12	12
,,	Field Experiments (Estate Trials) ...	18	18
,,	Growth of Budded Trees	—	1
,,	Purchases & Exchanges of Budwood	6	6
,,	Special Materials ...	2	2
		270	279
II. Tapping.	Estate Enquiries. General	94	90
,,	Estate Experiments General	36	31
,,	Estate Enquiries (Tapping of Budded Trees)	53	32
,,	Estate Experiments (Tapping of Budded Trees)	128	68
,,	Test Tapping of seedlings	3	3
		314	224

Analysis of Correspondence 1935

	Subject	Letters received	Letters despatched
III. Selection.	Individual Mother Trees; selection on estates	6	8
,,	Seed selection ...	2	2
,,	Latex Vessel and Bark Examinations ...	2	2
,,	Isolation Gardens ...	11	12
,,	Seed Germination ...	2	2
,,	Seeds for Experimental purposes	8	7
,,	Requests for seeds ...	5	6
,,	Type samples of seeds of proved clones ...	9	9
		45	48
IV. General.	Planting Enquiries ...		
,,	Information on planting Operations	5	7
,,	Replanting	94	102
,,	Cover Plants	81	86
,,	Catch Crops	2	2
,,	Thinning	4	4
		186	201
V.	Special Enquiries in connection with Rubber Assessment ...	42	47
VI.	Planting of Experimental areas on estates under the Rubber Regulation Scheme	74	83
VII.	Apparatus	3	1
VIII.	Miscellaneous	8	10
	Grand Total ...	942	893

Soils Division

Analysis of Correspondence 1935

Subject	Letters received	Letters despatched
Cultivation—General Enquiries ...	15	19
—Forestry Methods ...	20	21
—Experiments	32	32
Cover Crops and Natural Covers:		
—General Enquiries ...	114	122
—Manuring	6	6
—Eradication by Weed Killers	40	42
—Seeds	11	13
—Diseases	2	2
Manuring	207	221
Soil Conservation and drainage ...	11	10
Catch Crops	3	4
Replanting	124	142
Visits	39	66
Fertilizers	11	11
Soil Samples	58	59
Apparatus	2	2
Miscellaneous	20	36
	715	808

Chemical Division

Analysis of Correspondence 1935

Subject	Letters received	Letters despatched
Latex	42	56
Latex Preservation	145	149
Latex Concentration	55	67
Latex—Instrument for determining D.R.C.	119	140
Anti-coagulants of Latex	9	9
Anti-oxidants of Latex	1	1
Coagulants	67	76
Coagulating Tanks and Pans	12	12
Rubber Preparation—General Enquiries	27	24
Smoked Sheet	99	106
Air-dried Sheet	1	1
Crepe Rubber	23	25
Sole Crepe	1	1
Raw Rubber Powder	13	13
Water Samples	27	29
Machinery for Rubber Manufacture ...	53	55
Smoke Houses	161	223
Vulcanisation of Rubber	25	30
Accelerators for Vulcanisation ...	10	10
New Uses of Rubber	14	14
Softened Rubber	8	12
Rubber Substitutes	1	1
Rubber Paving for Road Surfacing ...	32	37
Rubber Paints	1	2
Rubber Seed Oil	3	3
Quebrachitol	4	5
Rubber Latex Paste	1	2
Patents	34	39
Orders for Chemicals, etc.	10	14
Apparatus	25	38
Miscellaneous	57	67
Total ...	1,080	1,261
Interviews		253
Visits paid to Estates		62

Pathological Division

Analysis of Correspondence 1935

Subject	Letters received	Letters despatched
Root Disease	99	109
Stem and Bark Disease	65	80
Leaf Disease	127	130
Fungicides and Insecticides	47	48
Tree Operations	5	3
Injury by external Agents	6	22
Insect Pests	45	42
Spraying and Dusting Equipments ...	14	23
Pathology of Buddings	1	2
Disease—General Treatment	131	171
Replanting	11	15
Lightning		
White Ant Treatment	4	7
Sulphur Dusting	17	19
Miscellaneous	46	63
Questionnaire on Replanting	44	96
Total ...	662	830

ANNUAL REPORT

SOILS DIVISION

Staff

Leave arrangements severely restricted the work of the Division. The Senior Officer was on home leave from 28th December, 1934 until 5th October 1935, and during his absence Mr. A. Moore, Advisory Officer, was in charge of the Division; in addition he carried out correspondence and visiting work for the Chemical Division.

Mr. R. A. Hamilton was appointed Soils Chemist, and assumed duty on 5th October 1935. Mr. A. Moore proceeded on home leave on 11th October 1935.

Amongst the Junior Staff, Mr. O. C. K. Raman was absent on long leave from 21st February to 23rd May, 1935, and a new laboratory assistant, Mr. K. Ratnasingam, was appointed, who assumed duty on 4th November, 1935.

Laboratory Work

The numbers of samples received, with the determinations carried out on them were as follows:—

	1931	1932	1933	1934	1935
Samples received ...	369	336	368	304	789
No. of Analytical determinations ...	2742	3473	3770	2138	3745

The large increase recorded here, amounting to more than double the number of samples received in previous years, occurred during the last two months of the year, when the Staff of the Division was nearly at full strength again and laboratory work was re-organised.

An analysis of the various determinations made in connection with soil investigations is as follows:—

Analysis of Routine Chemical Work, 1935

Loss on evaporation	...	...	...	213
Loss on ignition	...	...	...	295

Mechanical analysis	150
Sand fraction	143
Sticky point	143
pH	548
Conductivity	550
Carbon	316
Nitrogen	316
Total phosphate	141
Total potash	152
Available phosphate	100
Available potash	100
Nitrate	62
Carbon dioxide	4
Calcium	41
Acid soluble matter	6
Silica	6
Total number of determinations ...	3741

Advisory Work

There was no decrease in the large numbers of requests for advice necessitating in many cases visits to estates, which in spite of the lack of staff, it is satisfactory to record were carried out effectively.

Correspondence and Visits

The number of letters sent out (739) was an increase over 1934, and the 169 visits to estates represents an increase of 50 per cent over the previous year.

In the analysis of correspondence appended to the Director's report it will be seen that enquiries relating to manuring and replanting increased considerably during the year, whilst interest in covers, both leguminous and natural, was well maintained.

Replanting

The gradually awakening interest in replanting undoubtedly received considerable impetus from the official announcement that the loss of quota of exportable rubber would be only 110 lbs. per acre in respect of areas to be replanted, and this decided a large number of companies to undertake replanting.

From the few results of replanting trials, which are as yet available, it is apparent that in almost all situations successful replanting can be carried out, provided an adequate manuring

programme is adopted and also that physical conditions of the soil are not too adverse. On some soils, such as certain coastal clays, available plant foods are still sufficiently high to allow a reduction in the quantity of fertilisers required, but the need for adequate manuring in the early years cannot be over-emphasized; even on areas of more fertile soil reduced rates of manuring should not be started until the trees are a year or two old.

Wherever possible, an experimental lay-out is suggested involving the use of different covers and different manuring programmes, the variations in the latter being made with the object of determining the minimum amounts and most suitable type of manures needed to produce good growth.

Replanting in past years has usually been done on land which must be classed, from the point of view of soil fertility, as poor and, since no special efforts, *e.g.* manuring or use of leguminous covers, were made to improve the poor conditions, many of the earlier "replanted" areas have been very disappointing. The limitation under the Rubber Restriction Scheme of the amount of replanting which is permissible has led to the present replanting being carried out on soil which is "average" for the estate, the reason being that any replanting done now must be made a success. If the poorest soil is replanted the chance of success is small and, if results are poor, the area replanted represents so much waste of the total replantable acreage.

Another reason for choosing "average" soil is that it is typical of the estate and the results obtained are an indication of the potentialities of the major portion of the estate. Thus, valuable information will be obtained for future replanting.

On coastal clay soils, drainage is the limiting factor to plant growth and unless adequate drainage can be ensured, it is useless to replant. Drainage improvement may necessitate deepening drains and/or an increase in their number, bunding, and the addition of sluice gates. In one area, pump draining has been recommended.

Some of the first estimates of replanting costs appear to have allowed an insufficient sum for weeding. This naturally varies considerably in different situations and, on flat moist areas which have a heavy growth of grass in the old rubber, weeding costs will tend to be particularly high. Initial weeding rounds may be as high as $1/50 per acre per month, later rounds can eventually be reduced to normal weeding round costs which average $30/- per acre for the whole period of 6 years. The average is subject to considerable variation on either side under particular local conditions.

A saving in felling costs has been possible in a number of instances where timber has been utilised or sold. The local market for wood, however, quickly becomes saturated unless there is an unusual demand for firewood, as in some mining centres.

Manuring

Part of the increase in the extent of manuring of mature rubber can be attributed to the Rubber Restriction Scheme, since it is apparent that, with planting of jungle land prohibited and the amount of replanting restricted to 20 per cent of the planted acreage, a number of estates will have to depend for future crops on their present stand of mature rubber; hence the manuring of old rubber has to be considered in order to preserve its vigour and yielding capacity.

As it is proposed to publish a summary of results from manuring experiments during the coming year, 1936, no detailed comments on the progress of manuring will be made here.

Natural Covers

The position with regard to the growth of natural covers on estates is apparently becoming more stabilised and the principles underlying this practice more widely understood. Clean weeding has been abandoned on almost every estate and covers of desirable types are being grown.

Evidence is accumulating which indicates the physical benefit to the soil resulting from this practice and in due course it will be possible to demonstrate chemical improvements.

Improvements in the foliage and health of the rubber trees have been noted, following the introduction of natural covers, but no records are available yet showing the effect on yields.

Weedkillers

The position with regard to the use of chemicals for controlling the growth of either natural covers or undesirable weeds has been summarised and published in the Journal of the Institute.

Further trials with Calcium Cyanamide are being made, and it is hoped that amounts as low as 2 cwts per acre will prove effective in killing bracken and stagmoss. These experiments are in progress and will be reported upon during 1936.

Legal position with regards to use of sodium arsenite.

In connection with the use of poisonous weedkillers, *e.g.* sodium arsenite, the question has arisen of the liability of the estate for damage caused to animals which stray and graze on the sprayed

area; the Secretary of the United Planting Association of Malaya has expressed an opinion that, provided all reasonable precautions were taken, the estate would not be liable.

As "reasonable precaution" the following procedure is cited:—

(i) "to display notices large enough to be easily seen and read (say "6 × 2 ft. in size) at 200 yards intervals along the road frontage "of such estate stating, in English, that poisonous substances injuri- "ous to cattle, etc., are being used, and prohibiting cattle from "grazing in the said land

(ii) "to notify in writing the Officer-in-charge of the local Police, the "nearest Penghulu and the local Bengali temple (if there be one), "requesting them to inform persons likely to be grazing cattle in "the vicinity that poisonous substances are being used as weed- "killers or otherwise."

Estate Experiments

Growth measurements and yield records have been recorded during the year on the experimental areas on estates in which the Soils Division is interested but, owing to lack of staff, summaries and analyses of the figures have not yet been completed.

These estate experiments include cultivation experiments in which the effects of different types of natural and leguminous covers on rubber trees are being compared. Detailed cost figures are also being recorded.

Results from a number of manuring experiments also continue to be received, but although appreciable responses have been recorded in several cases, it is not possible to draw definite conclusions, mainly owing to lack of sufficient replication of the treatments or to unsatisfactory plot lay-outs.

Since the writer's return from leave a number of estate experiments have been started which are partly financed by the Institute; the plot lay-outs for these are such that definite information will become available. The experiments include experimental manuring in replanting and on old rubber trees under natural covers, also a comprehensive series of trials on coastal clay soils.

An extremely important development of estate experimental work has arisen out of the availability of reserve jungle land for purely experimental purposes. The Rubber Restriction Scheme permits planting up of reserve jungle land to the extent of $\frac{1}{4}$ of 1 per cent of the total planted acreage, *i.e.* Malaya is allocated about 8000 acres for this purpose.

Since such land is intended only for bona fide experiments, the Institute determines which estate applications represent suitable areas and have the facilities for carrying out desired experiments. Primarily these will be concerned with botanical work (*e.g.* testing

new planting material, comparison of clones on different soils and in different parts of the country, etc.) and soils work (methods of opening up jungle, methods of cultivation, types of covers, effects of manures on different soil types and on different clones, etc.)

The selection of suitable areas will depend upon the following factors:—soil type, lie of land, amount of soil variation, general suitability of the site and ease of access, supervision available, geographical position etc. Visits of inspection to individual estates will be necessary and, since a large number of applications for permission to carry out such planting are expected (exceeding the amount of land available) it will be necessary to visit the majority of the sites before any definite selections can be made, so that only a few areas can be selected for planting by the end of 1936.

Leguminous Covers

The possibilities of establishing leguminous covers, both bushes and creepers, under mature rubber trees have been examined by a number of estates. These tests have been made in areas which have little or no ground cover. Attempts to get covers to grow on these areas, by planting seeds or cuttings, should be made with the best types of covers, *i.e.* legumes, as these give the best justification for the expenditure.

The most successful method that has been used is one in which the covers are established in squares, about 6 ft. × 6 ft., which are trenched round in order to remove any competition by feeding roots from the rubber trees. A small amount of fertiliser can be applied in the square (or a rectangle if suitable) which will be utilised entirely by the growing cover.

Leguminous bush and creeping cover plants have been successfully grown by this procedure, and on one estate *Pueraria javanica* has spread and completely covered the area within nine months. Creepers appear to be more suitable under these conditions than bushes since by their spreading habit they are of benefit over a much larger surface. Bush legumes when established will not spread and will be of benefit only to the square in which they are growing, consequently the rubber will be affected only when its roots penetrate into these squares.

In several instances, too, bush legumes after some months have become badly infected with a white aphis insect which kills the plants. No economical control of this pest is possible and, where it appears in quantity, further supplying with bushes will be of little value. As it does not infest creepers, these should be supplied after a heavy attack.

Experiment Station

Girth measurements were taken on all the blocks in which the Soils Division is carrying out work, but the main point of interest lies in the first year's tapping results from the manuring experiment in Block 6.

A detailed discussion of the growth measurements and yield records at the Experiment Station will be published separately, but a brief reference to Block 6 will be made here.

Girth measurements, which for a long time showed that trees treated with cattle manure were significantly larger than any of the others, now show no significant differences, and at 7¼ years old the trees measure, all over, between 34 and 35 inches at 1 foot height.

There is, however, a significant difference in the yields over the first twelve months, and this is in favour of the trees receiving a complete inorganic fertiliser. The average yields are in the neighbourhood of 300 lbs. per acre.

It is apparent then from these observations that, in seedling rubber trees, girth measurements do not necessarily indicate the yielding capacity of the trees. It suggests rather that, although the trees are growing at their maximum rate on the natural fertility of the jungle soil, the additional nutrients supplied by the fertilisers can affect the latex production of the trees.

A manuring experiment similar to that in Block 6 has been designed for budgrafted rubber and the area was ready for planting at the end of the year. It will be referred to in future as Block 31.

Tapping was also commenced in Blocks 7, 8, 9 and 11 during the year.

Lake Gardens Area

No new developments are recorded here. The development and establishment of natural covers has continued and the nursery of typical covers found on estates has been steadily extended.

Research Work

In the absence of the necessary staff to carry out laboratory research work, this suffered very badly during the year, and it was only during the last 2 months of the year that it was possible to direct attention to this again.

It is hoped that during 1936, with the number of workers available, considerable strides can be made in the research programme which is contemplated.

Lectures

Two lectures on "Replanting" were given by Mr. A. Moore during the year:—

(1) at Malacca, 20th September, 1935, at the Annual Conference of the Incorporated Society of Planters.

(2) at Bentong, 29th September, 1935, to the Central Pahang District Planters' Association.

Publications.

The following articles were published in the journal during the year:—

"Use of Weed-Killers on the control of Natural Covers" by C. G. Akhurst

"Replanting" by A. Moore.

Conferences

The Third Congress of the International Society of Soil Science took place at Oxford, England, July 30th to August 7th, 1936, and was attended by the Senior Officer of the Division, who officially represented Malaya at the Conference.

A large number of vitally interesting papers were presented by members from all parts of the world, and it was possible to establish very useful contacts with other soil workers, particularly those in tropical Africa.

Summary of Rainfall at the Experiment Station

	1932	1933	1934	1935
January	4.92	6.06	11.01	5.46
February	8.98	6.69	5.85	3.85
March	10.51	19.17	13.36	6.69
April	6.19	16.35	12.01	7.04
May	8.67	9.41	4.55	5.01
June	2.40	2.76	6.05	5.74
July	2.77	4.62	5.62	2.35

		1932	1933	1934	1935
August	... ...	12.73	4.65	7.63	11.51
September	... ...	8.31	10.16	9.56	5.15
October	... ...	17.29	6.56	10.00	9.88
November	... ...	11.76	11.40	15.82	12.16
December	... ...	12.74	14.75	3.35	18.12
	Total ...	107.27	112.58	104.81	92.96

C. G. Akhurst

Senior Soils Chemist

ANNUAL REPORT

BOTANICAL DIVISION

During the year under review the shortage of staff in this Division was intensified by the incidence of long leave and very little new work was initiated, the available staff being fully occupied in advisory work and in the large amount of routine work involved in all investigations connected with a permanent crop such as Hevea.

Staff

Mr. C. E. T. Mann, Senior Officer of the Division left Malaya on long leave on 13th July and the writer who returned from long leave on 15th June has acted for him up to the end of the year.

Mr. H. Gunnery resigned his appointment and left Malaya in July.

Report on Investigations in Progress.

The different items in this report are arranged on the same general lines as in previous years.

I. Vegetative Propagation

(1) After-care of Budded Trees

A number of different methods of treating the exposed pruned area of the stock have been tried in Block 20 on the R. R. I. Experiment Station. The most satisfactory results were obtained by smearing a mixture of cattle manure and clay over the pruned surface of the snag and covering the mixture with a square of hessian cloth. A full description of the experiment will appear in the Journal.

C. C. T. S.

(2) Studies of the Growth of Budded Trees

(a) *Comparison of the growth of Buddings of different Clones under uniform Conditions on virgin Soil (R.R.I. Experiment Station, Block 5)*

The annual measurements* of the trees in this Block were taken in November and are set out in Table I.

*For previous reports see *Annual Report of R.R.I. of Malaya* (1929) 54; (1930) 59; (1931) 54; (1932) 59; (1933) 68; (1934) 67.

TABLE I. *Girth of Buddings under uniform Conditions; age 5—6 years, planted as budded Stumps in November 1929*

Plot Index	Clone	Mean girth in inches at 20 ins. from the union				Percentage tappable 1/1/36
		Nov. 1934	Nov. 1935	Increase 5th-6th year	Increase per cent.	
A	Avros 152	16.3	18.9	2.6 ins.	16.0	59
B	„ 49	16.7	19.6	2.9 „	17.4	63
C	Prang Besar 23	15.7	18.6	2.9 „	18.5	57
D	„ „ 186	17.8	20.5	2.7 „	15.2	74
E	Bodjong Datar 5	13.4	16.2	2.8 „	21.0	18
F	Tjirandji 1	17.6	20.7	3.1 „	17.8	76
G	Pilmoor A. 44	16.5	19.2	2.7 „	16.4	75
H	„ B. 84	18.8	22.6	3.8 „	20.2	86
J	Avros 50	16.7	19.5	2.8 „	16.8	64
	Mean of all Clones	16.6	19.5	2.9 „	17.5	64

The biggest increase in girth is made by Clone B. 84, which increases its lead as the most vigorous clone under test.

Clone B. D. 5 is still the most backward in growth, but the trees are now branching well and this clone has made the largest proportional increase in girth of the nine clones under test.

All trees with a girth of 18 inches at 40 inches from the union will be brought into tapping on 1st January 1936. The percentage of tappable trees at that date is also shown in the table.

C. E. T. M.

(b) *Comparison of the growth of Buddings of different Clones on a replanted Area (R.R.I. Experiment on an Estate)*

The previous history of this experiment has been given elsewhere.* Since the results obtained indicated that a complete fertiliser was necessary for replanting on this type of soil, 2 lbs of Enpekay No. 1 were applied to each tree in July 1935. Girth measurements were taken in October 1935 and are set out in Table II, together with

**Annual Report of R.R.I. of Malaya* (1930) 62; (1931) 57; (1932) 60; (1933) 69; (1934) 69.

the growth records of the same clones at the same age grown on virgin soil of a similar geological origin.

TABLE II. *Rate of Growth of budded Trees on virgin Soil and in a replanted Area*
Age of trees—5 years

A. *Planted as budded stumps in October 1930*
B. *„ „ „ November 1929*

	Clones	Mean girth in ins. at height of 20 ins. from the union		Ratio B/A		
		Replanted Area A	Virgin Soil B	5th year	4th year	3rd year
A	Avros 49	12.0	16.7	1.4	1.5	1.7
B	„ 50	12.3	16.7	1.4	1.3	1.6
C	Bodjong Datar 5	10.8	13.4	1.2	1.2	1.4
D	Tjirandji 1	13.1	17.6	1.3	1.4	1.8
E	Pilmoor B. 84	11.6	18.8	1.6	1.4	2.0
F	Glenshiel 1	11.9	—	—	—	—
Mean Clones A to E		12.0	16.6	1.4	1.4	1.7

No further reduction in the ratio of growth in virgin and replanted areas can be recorded. The interval of nineteen months that elapsed between the 1935 application of manure and the previous application and the fact that girth measurements were taken only three months after the last application could account for this.

Each of the 36 plots in this experiment was divided into four square sub-plots a, b, c and d and the following cultivation and manuring treatments were applied to each sub-plot.

Sub-plot (a) July 1933 Covers turned in between the rows.
Jan. 1934 1 lb. sulphate of ammonia per tree
July 1935 2 lbs. Enpekay No. 1 per tree

Sub-plot (b) July 1933 Covers turned in between rows.
Jan. 1934 1 lb. sulphate of ammonia and
½ lb. sulphate of potash per tree
July 1935 2 lbs. Enpekay No. 1 per tree

Sub-plot (c) July 1933 2 lbs. rock phosphate, 1 lb. sulphate of ammonia per tree
Jan. 1934 1 lb. sulphate of ammonia per tree
July 1935 2 lbs. Enpekay No. 1 per tree

Sub-plot (d) July 1933 2 lbs. rock phosphate and 1 lb. sulphate of ammonia per tree
Jan. 1934 1 lb. sulphate of ammonia ½ lb. sulphate of potash per tree
July 1935 2 lbs. Enpekay No. 1 per tree

The girth measurements of the four sub-plots are shown in Table III.

TABLE III. *Effect of certain manuring and cultivation Treatments on the Growth of budded Trees in a replanted Area.*

	Girth in ins. at 20 ins. from union			Percentage increase	
	Feb. 1934	Dec. 1934	Oct. 1935	Feb.—Dec. 1934	Dec. 34—Oct. 35
Sub plot (a)	5.8	8.5	11.3	46.6	33.2
„ (b)	5.9	8.6	11.6	45.7	34.9
„ (c)	6.2	9.3	12.5	50.0	34.4
„ (d)	6.1	9.3	12.5	52.4	34.4

The increase in growth between December 1934 and October 1935 is uniform in all plots.

There seems to be no effect on growth attributable to potash and the effect of the application of phosphate in July 1933 appears to have worn off.

C. E. T. M.

(c) *Influence of Density of Planting on Growth and later Development of Budded Areas (R.R.I. Experiment Station, Block 14 C and D)*

A further series of growth measurements* was taken in December when the trees reached the age of 5 years from planting as budded stumps. The results are summarised in Table IV.

Annual Report R.R.I. of Malaya (1930) 62; (1931) 57; (1932) 60; (1933) 69; (1934) 69.

TABLE IV

TABLE IV.—*Comparison of the Growth of Buddings of Clone SF.32.S 50 at different planting Densities*

Plot Index	Planting Distance. feet	No. of trees per plot	Mean Girth (ins.)			Girth as percentage of B. plots 1935
			Dec. 1934	Dec. 1935	Increase	
A	30 x 30	54	12.1	16.1	4.0	102
B	20 x 20	117	12.1	15.8	3.7	100
C	14 x 14	247	11.5	14.8	3.3	94
D	12 x 12	320	11.7	14.1	2.4	89
E	10 x 10	468	11.1	13.2	2.1	84
F	20 triangular	125	12.1	15.9	3.8	100

The effect of the density of planting is now apparent at all planting distances. The increase in girth at the highest planting density was only just over half that of the lowest density.

The experiment is laid out as a Latin square with six plots of each planting density. In the western half of the experimental area the timber was felled and allowed to rot on the ground; in the eastern half all the surface timber was removed. The mean girths in the western and eastern halves were 38.6 and 37.5 inches respectively. The difference of 1.1 inches is an increase over that of 1934 when the difference was only 0.6 inch.

C. E. T. M.

(3) The Mutual Relationship between Scion and Stock in Buddings

Influence of Scion on Yield of Stock

In the Annual Report for 1934 reference was made to the setting up of an experiment in Block 22B with twin seedlings from illegitimate seeds of various clones.

One half of the pairs of seedlings remained unbudded, while three clones were used for budding one member of each pair of the other half.

To level up the rate of growth and to prevent the unbudded trees from over-shadowing the budded trees, all

the unbudded trees were pollarded at eight feet from the ground in July.

C. E. T. M. and K. N. K.

Use of special Stocks for Budding

(i) No seed of either *H. spruceana* or *H. brasiliensis* was obtained during the year from the isolated seed gardens. It is hoped that seed will be set during 1936 and that the experiments to test the value of stocks of another species of Hevea will be initiated.

C. E. T. M.

(ii) In block 14 E on the Experiment Station illegitimate seedlings of Clones Pilmoor A. 44, B. 50 and B. 58 and illegitimate seedlings from an area of mixed buddings of M.A.P. clones were planted in November 1931. Half the area was budded with P.B. 186 in December 1932.

Girth measurements of the unbudded and budded trees, taken in October 1935, are set out in Table V.

TABLE V. *Comparison of the Growth of budded and unbudded Clonal Seedlings*

Type	Unbudded Trees			Budded Trees		
	No. of Trees	Girth at 20 ins. from collar cm.	Deviation from mean	No. of Trees	Girth at 40 ins. from union cm.	Deviation from mean
A. 44	116	43.2	— 1.5	95	20.3	— 1.0
B. 50	116	47.8	+ 3.1	98	22.8	+ 1.5
B. 58	154	46.7	+ 2.0	139	21.5	+ 0.2
M.A.P.	114	41.2	— 3.5	102	20.8	— 0.5
Mean		44.7			21.3	

The difference in growth of the scions budded on to these four types of clonal seed is small, but in general the scions budded on to the more vigorous stock show the more vigorous growth.

C. C. T. S.

II. The Physiology of *Hevea brasiliensis* in relation to Latex Production

Under this heading are included all experiments in which the tapping system and its effects on the trees tapped are the subjects under investigation.

The results of tapping experiments will occur elsewhere in this report but in such cases they are incidental to the proving of new planting material; it is the new material and not the tapping system that is under investigation.

(1) Tapping Experiments on mature Trees grown from Seed

(a) *Experimental work in the Lake Garden Area (30 acres)*

Normal alternate-daily tapping was continued throughout the year.

The small plot of trees in the road reserve adjoining Block A which had not been tapped before reaching the age of at least 20 years was tapped alternate-daily throughout the year.* In April the tapping cuts reached ground level and new cuts were opened on the opposite side.

In March 1933, when tapping first commenced in this Block, alternate trees were opened with a "V" cut and with a single spiral cut. When the new panels were opened the trees which were originally tapped on a "V" cut were tapped on a spiral cut and vice versa. The yields obtained will be found in Table VI.

Table VI. *Comparison of Yields from Trees tapped alternate-daily with a single spiral Cut and with a "V" Cut.*

Group	First Period 26 months March 1933 — April 1935					Second Period 8 months May 1935 — December 1935				
	Tapping System	No. of Trees	Mean Girth at 20 ins.	Yield		Tapping System	No. of Trees	Mean Girth at 20 ins.	Yield	
				lb. per tree per annum	per cent				lb. per tree per annum	per cent
			ins.					ins.		
I	Single cut	32	46.0	20.0	124	V cut	30	53.0	17.2	117
II	V cut	32	43.0	16.2	100	Single cut	30	49.4	14.7	100

* *Annual Report R.R.I. of Malaya* (1934) 74.

For unselected seedling rubber the yields must still be regarded as exceptionally high.

It is clear that the inherent yielding capacity of the two groups is very different and that during the first period the excess of yield in the single-cut group of 24 per cent was mostly due to the inherent yielding capacity of the trees and not to the difference in tapping systems.

During the second period the first group continued to give a higher yield than the second group but the excess was smaller when tapped on a "V" cut than when tapped on a single spiral cut.

C. E. T. M.

(b) *Investigations of economic Tapping Systems. Experiment on Seventh Mile Estate*

In continuation of previous reports* the results obtained during the first six months of the third year of this experiment are set out in Table VII.

TABLE VII. *Tapping Experiment on Seventh Mile Estate June—Nov. 1935*

Tapping System	Period		Yield of First grade rubber		Yield of Scrap Rubber		Total Yield	
	Tapping months	Rest months	lb.	Per Cent of Control	lb.	Per Cent of First Grade	lbs.	Per Cent of Control
A.B.C.	6	3	251.4	83.9	25.8	10.3	277.2	82.3
A.B.C.	10	5	249.0	83.1	27.0	10.8	276.0	81.9
A.B.C.	14	7	233.8	78.1	24.2	10.4	258.0	76.6
Sunderland	3	3	195.3	65.2	28.5	14.6	223.8	66.4
Sunderland	5	5	211.7	70.9	34.5	16.3	246.2	73.1
Sunderland	7	7	202.0	67.4	32.8	16.2	234.8	69.7
Double four	Continuous	Nil	285.5	95.3	52.0	18.2	337.5	100.1
Control A.D.	,,	Nil	299.5	100.0	37.5	12.5	337.0	100.0

NOTE 1. Sunderland System. Two half-circumference cuts on opposite sides of the tree tapped every third day with periods of rest alternating with equal periods of tapping.

NOTE 2. Double four. Two half-circumference cuts on opposite sides of the tree tapped every fourth day. Originally no periods of rest were allowed but owing to the unavoidable increase in bark consumption

**Annual Report R.R.I. of Malaya* (1933) 78; (1934) 75. *Journal R.R.I. of Malaya* 5, 320; 6, 105.

the system was altered to double-four A.B.C.D. from the 1st October, 1935. One section of each of the double-four plots is to be rested in rotation for four months, to be followed by a period of tapping of 12 months.

Note 3. The control plots were tapped alternate-daily on a half-circumference without rest.

Compared with the control, the yields of the other tapping systems appear to have fallen below those of the second year. This is possibly due to the fact that during the second year two-thirds of the length of the tapping cuts of the control plots passed over the junction of virgin bark and renewed bark with the result that the yields of the control plots were temporarily depressed.

Further comment on these results will be postponed until the results for the whole of the third year are available.

C. C. T. S.

(c) *Bark Consumption Experiment*

An experiment to show the influence of bark consumption on yield was set up on the R.R.I. Experiment Station (Block 13).

Three rates of bark consumption were compared, namely, $\frac{3}{4}$, 1 and $1\frac{1}{4}$ inches per month. The tapping system was alternate-daily on a half-circumference. All plots were tapped on the same day by a Chinese tapper who had previously been employed as a budding labourer. The standard of tapping was very much above the average.

At the end of the first year the total yields of the plots with $\frac{3}{4}$, 1 and $1\frac{1}{4}$ inches bark consumption per month were in the proportion of 100 : 98.5 : 99.3 respectively. The differences are without significance.

Since it was thought that the negative results obtained might be due to the exceptional skill of the tapper new panels were opened on the opposite side of the tree and the experiment is being repeated, but a Tamil tapper of average skill is employed in place of the Chinese tapper. The experiment is still in progress.

C. C. T. S.

(d) *Tapping Experiments in Block 6*

The trees tapped in this experiment consist of the boundary rows of the plots in the manurial experiment. (R.R.I. Experiment Station, Block 6). The experiment

started in August 1935. The following tapping systems are being compared:—

System 1. Alternate-daily tapping on two half-spiral left to right cuts—one opened at 40 inches and the other at 20 inches on the opposite side with periods of 3 months' rest alternating with periods of 3 months' tapping.

„ 2. Fourth-daily tapping on two cuts as in system 1, but without rest periods.

„ 3. As in system 2 but tapped on a full-spiral cut opened at 30 inches from the ground.

„ 4. Control—Alternate-daily tapping on a single half-spiral left to right cut, group (a) opened at 40 inches and group (b) opened at 20 inches from the ground without rest periods.

Each system of tapping is carried out on rows running north to south and replicated on rows running east to west. One tapper only is employed in this experiment.

The yields obtained from August to December are summarised in Table VIII.

TABLE VIII. *Tapping Experiments on seedling Trees*
Block 6. R.R.I. Experiment Station
Age on 1.1.1935—6 years 2 months

Tapping System	Period		Mean yield per tree per tapping gm.	Equivalent in pounds per tree per annum	Yield per annum as percentage of control
	Tapping (months)	Rest (months)			
1. Double-cut alternate-daily	6	6	15.5	2.73	86
2. Double-cut fourth-daily	continuous	Nil	17.3	3.05	96
3. Full spiral cut fourth-daily	„	„	18.2	3.20	101
4. Single-cut alternate-daily	„	„	9.0	3.17	100

NOTE:—The yield in pounds per annum is calculated on the basis of 160 tapping days for the alternate-daily and 80 tapping days for the fourth-daily tapping systems.

The difference between systems 2, 3 and 4 are not significant but they are probably all significantly better than system 1.

In our experiment on Seventh Mile Estate* the double-four system showed a saving in tapping costs of 25 per

**Journal R.R.I. Vol. 5, No. 4*

cent. In a small scale experiment such as this it is not possible to estimate the tapping costs but it would be reasonable to expect that with a single full-spiral cut they would be even lower than with the double-four system.

K. N. K.

(2) Tapping Experiments on Budded Trees

(a) *Study of Budded Trees under Normal Tapping Systems*

Tapping was continued as in previous years on the clones established on Pilmoor Estate. The most important records are summarised in Table IX.

Table IX. *Summary of Records of Growth, Yield and Dry Rubber Content of the Latex of Budded Trees of the principal Pilmoor Clones*

(a) *Trees tapped alternate-daily*

(b) *Trees tapped daily in alternate months*

Year	Mean Age of Trees	Mean Girth of Trees in inches at height of 40 inches from union										
		A.44		B.58		B.84		D.61		B.16		D.65
	Years	a	b	a	b	a	b	a	b	a	b	a
1927	3	11.8	11.7	12.2	12.0	13.4	13.0	10.4	11.2	9.2	9.3	13.3
1928	4	15.0	15.1	15.0	14.9	17.1	17.2	12.9	13.8	12.9	12.9	16.5
1929	5	18.7	19.0	19.2	18.8	22.0	22.2	...	...	19.8	19.5	22.8
1930	6	20.8	20.8	20.6	19.8	24.8	24.7	19.3	21.0	21.3	21.5	26.6
1931	7	23.3	23.3	21.8	21.7	27.7	27.5	21.8	23.8	24.5	24.7	30.1
1932	8	24.7	24.4	23.2	22.0	30.5	29.8	23.2	25.4	26.6	26.4	31.9
1933	9	25.7	25.2	25.2	24.1	33.1	32.4	25.4	28.5	28.6	28.2	33.8
1934	10	27.6	26.4	26.7	25.2	36.0	34.4	27.3	30.3	30.4	29.5	36.4
1935	11	28.6	26.9	27.5	25.8	37.6	35.3	28.8	32.0	31.2	30.7	37.3

Mean Yield per Tree in pounds dry Rubber per Annum

1928	3½	4.4	...	2.6	...	3.8	...	...	...	...	...	...
1929	4½	6.0	5.5	4.2	4.8	5.2	6.9	5.1	...	5.5	4.9	4.5
1930	5½	6.6	6.6	7.2	6.8	7.1	8.1	6.3	6.2	8.7	8.1	11.0
1931	6½	7.1	8.0	8.7	9.0	9.2	11.3	8.2	8.8	11.4	11.8	15.9
1932	7½	8.2	8.6	10.2	10.6	12.3	14.3	9.5	10.9	13.0	13.4	19.0
1933	8½	9.3	8.9	9.6	10.8	15.9	18.5	7.1	10.0	15.1	17.3	20.0
1934	9½	9.5	10.3	12.9	13.7	18.5	20.0	10.9	13.9	18.6	20.6	26.0
1935	10½	10.0	9.7	14.6	14.2	19.2	19.4	11.8	15.1	19.1	20.5	23.2

Percentage dry rubber Content of Latex; Mean for each tapping Year

1931	6½	33.6	34.1	37.9	34.1	35.4	33.4	33.4	32.1	36.4	34.6	32.2
1932	7½	37.7	36.8	43.0	37.3	39.0	35.2	32.7	33.9	37.9	36.1	34.5
1933	8½	37.1	37.5	43.5	40.3	36.6	34.3	34.8	36.3	37.3	36.6	32.7
1934	9½	39.3	38.6	42.7	38.1	38.0	35.3	35.5	37.3	39.9	37.8	32.8
1935	10½	39.1	38.5	42.4	38.2	38.2	35.6	36.7	35.1	39.5	37.0	31.0

That the general conditions for growth during 1935 were not good is shown in Table IX, the increase in girth between 1933 and 1934 being nearly double the increase between 1934 and 1935. As would naturally be excepted there has been a corresponding falling off in the yields. The yields of Clones A.44, B.84 and B.16 have remained about stationary, D. 65 has declined, and only B.58 shows any appreciable increase. Even then the latter only shows an increase of 8 per cent compared with 30 per cent in the preceding year.

The advantage obtained by the daily alternate-monthly tapping over alternate-daily tapping in 1934 has not been maintained in 1935. Only in the case of D.61 has the former system retained its advantage. In the other four clones the advantage of the daily alternate-monthly system has either been reduced or negatived.

Except in the case of D.61, the girths of the clones in groups (a) and (b) were nearly equal in 1927. By 1935 the girths in group (a) were, with the same exception, higher than in group (b). It would seem that the greater yields realised from the daily alternate-monthly system have been obtained at the expense of part of the increase in girth that would presumably have occurred if they had been tapped on the alternate-daily system.

C. E. T. M. and K. N. K.

(b) *Influence of tapping Height on Yield of budded Trees and Seedlings*

The experiments with clones B.50 and B.95 have been continued. Further data are available from nine clones established in Block 5 and from seedling trees in Block 6 of the Experiment Station. The former were tapped from February 1935 and the latter from August 1935. The yields are summarised in Table X.

TABLE X. *Yield of Budded and Seedling Trees at different tapping Levels*

Heights given are those measured at the beginning of the tapping year.

Clone	Tapping Year	Age on Jan. 1st of the year	Yields in grm. per tapping at heights of :—				
			10 inches	20 inches	30 inches	40 inches	50 inches
B. 50	1933	8 yrs. 2 ms.	18.2	16.2	14.8	14.0	12.6
	1934	9 „ 2 „	21.3	16.4	16.5	15.5	12.1
	1935	10 „ 2 „	22.7	17.4	18.3	16.4	12.1
B. 95	1933	8 „ 2 „	—	17.1	—	14.0	—
	1934	9 „ 2 „	18.2	—	17.7	—	—
	1935	10 „ 2 „	—	18.9	—	14.5	—
A.V.R.O.S. 152	1935	5 „ 1 „	—	10.0	—	8.0	—
„ 49	„	„ „ „ „	—	11.3	—	10.0	—
P.B. 23	„	„ „ „ „	—	15.3	—	12.8	—
„ 186	„	„ „ „ „	—	14.9	—	12.7	—
B.D. 5	„	„ „ „ „	—	9.6	—	8.0	—
Tj. 1	„	„ „ „ „	—	17.3	—	17.7	—
Pilmoor A. 44	„	„ „ „ „	—	20.6	—	17.9	—
„ B. 84	„	„ „ „ „	—	12.7	—	13.5	—
A.V.R.O.S. 50	„	„ „ „ „	—	8.8	—	8.5	—
Seedlings	„	6 „ 2 „	—	11.7	—	6.3	—

The relatively small decrease in yield with increase in the height of the tapping cut in the case of budded trees is again demonstrated. There is actually a small increase in yield in the case of Clones Tj.1 and Pilmoor B.84 at 40 inches. With seedling trees, on the other hand, there is a decrease of 46 per cent when the tapping height is increased from 20 inches to 40 inches.

C. E. T. M. and K. N. K.

(c) *Influence of the Direction of the tapping Cut*

The experiment set up in 1933 on Clone B.95 was continued throughout the year (Table XI)

TABLE XI. *Influence of the Direction of tapping Cut on Yield of budded Trees*

Clone	Tapping Year	Yield in Grm. per Tree per Tapping		
		Tapped left to right	Tapped right to left	Right to left as per cent. left to right
B. 95	1933	14.0	10.3	74.6
	1934	17.7	14.6	82.5
	1935	18.6	17.1	92.0

During the year the height of the tapping cut was lowered from 22 to 13 inches. As the experiment progresses the difference in yield gets steadily smaller. This is in accordance with the results obtained elsewhere with seedling trees.

C. E. T. M. and K. N. K.

(d) "Double Cut" tapping System on budded Trees

(i) *Pilmoor Estate*

The experiment with clones B.95, C.94, B.65 and D.29 described in the Annual Reports for 1933 and 1934 was continued in 1935. The results are summarised in Table XII.

TABLE XII. *Comparison of Yields of budded Trees on single and double-Cut tapping Systems (Pilmoor)*

System of Tapping	Tapping Period	Average yield per tree in gm. per tapping and pounds per annum. (160 tappings for single cuts and 80 tappings for double cuts)							
		Clone B. 95		Clone C. 94		Clone B. 65		Clone D. 29	
		gm	lb	gm	lb	gm	lb	gm	lb
Single tapping cut on half-circumference	Apr. 1933-Mar. 1934	13 7	4.8	20.7	7.3	20.6	7.2	16.6	5.8
	„ 1934- „ 1935	16.8	5.9	26.2	9.2	25.3	8.9	22.6	7.9
	„ 1935-Dec. 1935	16.7	5.9	29.2	10.3	26.3	9.3	25.3	8.9
Two cuts on opposite panels both on half-circumference	Apr. 1933-Mar. 1934	30.7	5.4	34.2	6.1	38.1	6.8	30.3	5.4
	„ 1934- „ 1935	40.1	7.1	49.9	8.8	50.0	8.8	38.7	6.9
	„ 1935 Dec. 1935	49.0	8 6	58.9	10.4	58.8	10.4	60.3	10.6
Yield of double-cut trees as per cent yield of single-cut trees	Apr. 1933 Mar. 1934	113		84		94		93	
	„ 1934- „ 1935	120		96		99		87	
	„ 1935-Dec. 1935	146		101		112		119	

Note:—Clone B. 95. Double-cut trees tapped alternate-daily for periods of 3 months and rested for periods of 3 months
Single-cut trees tapped alternate-daily
Clones C. 94, B. 65 and D. 29.
Double-cut trees tapped daily for 15 days and rested for 45 days.
Single-cut trees tapped daily in alternate months.
There are 20 trees of each clone in tapping, ten trees on each system.

The trees appear to suffer no ill-effects from these severe tapping systems and bark renewal is normal.

(ii) *Block 5. R.R.I. Experiment Station*

This block contains four square plots of each of nine clones. The four boundary rows of each plot were tapped on the following systems:—

1. Alternate-daily on a half-circumference at 40 ins. from the union.
2. Alternate-daily on a half-circumference at 20 ins. from the union.
3. Two half-circumference cuts on opposite sides of the tree at 20 and 40 ins. from the union tapped A.D. Three months tapping and three months rest.

The east and west boundary rows were allotted to systems 1 and 2, the north and south rows to system 3. The north and south rows were tapped in alternate periods of three months. Systems 1 and 2 were brought into tapping on 1st February, system 3 on 1st May. The results to the end of the year are shown in Table XIII.

TABLE XIII. *Comparison of single and double-Cut tapping Systems on young budded Trees (Block 5. Experiment Station)*

Tapping Systems	Mean yield per tree in gm. per tapping and equivalent in lb. per tree per annum. (160 tappings on single cut and 80 tappings on double cut)								
	CLONES								
	Av. 152 gm. lb.	Av. 49 gm. lb.	P.B. 23 gm. lb.	P.B. 186 gm. lb.	B.D. 5 gm. lb.	Tj. 1 gm. lb.	A. 44 gm. lb.	B. 84 gm. lb.	Av. 50. gm. lb.
1. Single-cut A.D. at 20 ins.	10.0 3.5	11.3 4.0	15.3 5.4	14.9 5.3	9.6 3.4	17.3 6.1	20.6 7.3	12.7 4.5	8.8 3.1
2. Single-cut A.D. at 40 ins.	8.0 2.8	10.0 3.5	12.8 4.5	12.7 4.5	8.0 2.8	17.7 6.2	17.9 6.3	13.5 4.8	8.5 3.0
3. Two cuts at 20 ins. and 40 ins. A. D. Three months tapping, three months rest.	17.0 3.0	20.4 3.6	25.5 4.5	23.8 4.2	12.9 2.3	29.9 5.3	27.8 4.9	26.3 4.6	18.8 3.3
System 3 as a percentage of the mean of systems 1 and 2.	94	96	91	86	73	86	72	100	109

Seven cases of Brown Bast occurred, five in A.44 and one each in Tj.1 and P.B. 23. Except for one tree of A.44 all cases occurred in the double-cut tasks.

The trees in this block were planted as budded stumps in November 1929 and were five years and three months old in February 1935 when tapping on the single cuts was commenced.

C. E. T. M. and K. N. K.

(e) *Influence of different tapping Systems on the Yield of Buddings*

The experiments with different tapping systems on clones Glenshiel 1 were continued during 1935.

The older group of trees tapped third-daily on a half-circumference was originally tapped A.D. on a half-circumference and no period of rest intervened when the tapping system was changed.

The suggestion that continuous A.D. tapping on a half-circumference is too heavy a system for this clone is borne out by the results of tapping during the year which show very satisfactory results for the lighter tapping systems (Table XIV).

TABLE XIV. *Yield of Buddings of Clone Glenshiel 1 on different tapping Systems*

Tapping Systems	Age on 1.1.35	Yield in gm. per tree per tapping and in lb per tree per annum (160 tappings)			
		1934		1935	
	Years	gm.	lb.	gm.	lb.
A. D. on ½ Circumference	13	62.7	22.1	57.7	20.3
A. D. on 1/3 Circumference	13	48.3	17.0	47.8	16.8
Third-daily on ½ Circumference	13	64.9	22.9	69.3	24.4
A. D. on ½ Circumference	7½	21.0	7.4	28.1	9.9
A. D. on 1/3 Circumference	7½	26.2	9.2	29.6	10.4
Third-daily on ½ Circumference	7	25.0	8.8	24.0	8.5

We must again express our indebtedness to Mr. J. H. N. Bailie and to Mr. W. A. D. Wynch for their willing co-operation and for their permission to publish the results.

C. E. T. M.

(3) Anatomical Investigations

The investigations of the anatomy of the sieve tubes and its relationship to the yielding capacity of Hevea were concluded and the results published in the Institute Journal (Vol. 6, No. 1).

On the resignation of Mr. Gunnery further investigation of the anatomy of *Hevea* was discontinued. It is hoped that this work will be resumed and extended when sufficient staff is available.

H. G.

III. Selection and Breeding.

(1) Selection of high yielding Trees on Estates and the Establishment of new Clones

The work on the new clones established prior to 1935 was confined to maintenance and observations on growth.

In addition small plots of fifteen new estate clones were budded on the Experiment Station for comparison with a standard clone.

C. C. T. S.

(2) Artificial Pollination and Breeding

(a) No extension of the work of artificial pollination has been made during the year.

(b) *First series of hand-pollinated seedlings*

Those of the first series of artificial pollinations made in 1928—1929 which had reached a girth of 20 in. at 20 in. from the ground were brought into regular alternate-daily tapping on a half-circumference on 1st January 1935 (Block 4, R.R.I. Experiment Station).

The yields of the 167 trees of the different families of crosses are recorded in Table XV.

TABLE XV. *Yields of the 1928 Crosses—January-December 1935*
Legitimate Seedlings

Age in January 1935, 5 years 8 months

Cross M. F.	No. of trees tapped.	Yield : gm. per tree per tapping			Coefficient of Variability
		Mean	Lowest	Highest	
A. 8 × A.44	5	18.0	11.5	28.5	
A. 8 × B.58	2	8.2	5.3	11.1	
B.58 × A. 8	16	16.0	6.6	33.2	
A.44 × B.58	11	19.5	6.0	37.7	
A.44 × D.61	30	22.4	8.4	46.7	40.3
A.44 × B.16	24	21.8	8.8	40.6	43.1
B.58 × A.44	2	25.3	20.7	30.0	
B.84 × A.44	6	25.4	8.3	43.9	
D.61 × A.44	42	22.1	7.2	48.7	48.0
B.16 × A.44	7	22.2	12.9	40.2	
B.95 × A.44	9	16.7	7.1	31.7	
B.58 × D.61	4	8.9	8.3	11.1	
B.58 × B.16	5	20.6	14.8	29.4	
B.16 × B.58	1	12.2	—	—	
D.61 × B.16	3	13.2	12.3	14.0	

As expected from the results of the previous test-tappings, all families with A.44 as one of the parents have shown yields which are substantially higher than those that would be expected from ordinary seedling rubber. The family B.84 × A.44 is outstanding. The highest yielding tree (No. 269/3) is in the D.61 × A.44 family and yielded 17.8 lbs of dry rubber, a satisfactory performance for a tree of this age.

Five cases of Brown Bast occurred: one each in the A. 44 × B. 16, D. 61 × A. 44 and B. 58 × D. 61 families and two in the B. 84 × A. 44 family.

Before being affected with Brown Bast one of the trees in the B. 84 × A. 44 family had yielded 16.3 lbs. of dry rubber during the period January-July.

C. E. T. M. and K. N. K.

(c) *Second Series of hand-pollinated Seedlings*

The second series of hand-pollinations was planted in October—November 1929 and February—April 1930 (R.R.I. Experiment Station. Block 16.)

All trees that had attained a girth of 18 ins. at 20 ins. from the union were tapped alternate-daily on a half-circumference cut from 1st April. The yields obtained from the various crosses are shown in Table XVI.

TABLE XVI. *Yields of the 1929 Crosses (April-December 1935)*
"Legitimate Seedlings"

Crosses Male Female	First seeding season Crosses 1929 (Planted Oct.-Nov. 1929)		Second seeding season Crosses 1929 (Planted Febr.-Mar.-Apr.-1930)	
	No. of trees tapped	Mean Yield per tree per tapping grm.	No. of trees tapped	Mean Yield per tree per tapping grm.
A.44 × B.50	16	12.1		
A.44 × B.58	24	12.6		
A.44 × B.84	1	31.0	7	10.1
A.44 × D.61	15	14.4	46	13.7
A.44 × B.16			59	12.8
A.44 × Lund N			14	16.7
B.58 × A.44	16	13.7	13	10.9
B.84 × A.44	31	17.8	24	16.5
D.61 × A.44	19	13.8	34	12.7
D.65 × A.44			4	7.8
B.16 × A.44			18	16.1
B.50 × B.58	12	9.6		
B.50 × E.95	2	15.3		
B.58 × B.50	9	11.6		
B.58 × B.84	9	16.3		
B.58 × C.72	3	12.6		
B.58 × B.16			4	14.3
B.84 × D.61	11	13.9		
B.84 × D.16			25	12.3
C.72 × B.84	5	13.2		
D.61 × B.84	30	12.5		
B.16 × B.84			5	12.0
D.61 × B.16			2	9.7
D.55 × B.16			4	12.6
B.16 × D.61			3	3.4
Lund K × Lund N			1	9.8
Buddings A.44			16	14.75
„ B.84			32	7.8

Note.—28 of the Budded Stumps of B. 84 were planted in Jan. 1930.

The results are in fairly close agreement with those obtained from the first series of crosses, and A. 44 is again shown to be a good parent tree.

In the first series of crosses the only trees with B. 84 as a parent were obtained by crossing B. 84 with A. 44 and the merits of the former as a parent could not be determined. The results of the second series indicate that B. 84 is as good a parent as A. 44.

Of the first seedling season crosses the 122 trees with A. 44 as a parent yielded on the average 14.5 gms. per tapping and the 87 trees with B. 84 as a parent 15.2 gms. The 32 trees of the B. 84 × A. 44 cross and its reciprocal gave a mean yield of 18.2 gms. per tapping.

Budded stumps of Clones B. 84 and A. 44 were planted in May 1930 in the same block. The early growth of the budded stumps in this block was very poor. At four years of age the girth of A. 44 was only equal to 66 per cent of the girth of the same clone in Block 5 at the same age and B. 84 to only 86 per cent of the girth in Block 5. It is possible therefore that the comparison of the yields of the legitimate seedlings with the buddings is rather flattering to the former.

C. E. T. M. and K. N. K.

(3) New Clones derived from legitimate Seedlings of the first series of Hand-Pollinations

In November 1930 buds were taken from a large number of the legitimate seedlings obtained from the first series of hand-pollinations. The buds were taken from a point between 40 and 60 ins. from the ground and were used for budding seedling stocks in the field (R.R.I. Experiment Station, Block 3.) By this means six budded trees of each of 180 new clones were established.

All trees which had attained a girth of 16 ins. or more at 20 ins. from the union were tapped alternate-daily on a half-circumference cut at 20 ins. from the union from 1st July. An analysis of the yields of the different clones will not be made until a larger 1—2 proportion of the trees have been brought into tapping. The yields of the clones derived from the different families of legitimate seedlings are set out in Table XVII.

TABLE XVII. *Results of Test-tapping of Buddings established from Crosses (legitimate Seedlings).*

Age in July 1935—4 years 7 months

Clones from seedling families of :—	No. of trees tapped	Yield : gm. per tree per tapping		
		Mean grm.	Lowest grm.	Highest grm.
A. 8 × A.44	10	5.3	3.2	8.3
B.58 × A. 8	7	3.3	2.3	4.3
A.44 × B.58	9	4.1	2.4	8.3
A.44 × D.61	95	6.1	1.5	19.3
A.44 × B.16	56	5.5	1.9	23.2
B.58 × A.44	1	4.4		
B.84 × A.44	18	8.1	2.7	20.9
D.61 × A.44	47	4.9	0.8	9.3
B.16 × A.44	14	8.3	4.8	16.2
B.95 × A.44	1	4.2		
A.V.R.O.S. 50	4	4.5	3.0	5.9

A number of buddings of Avros 50 were made at the same time and are included in this block as a control. Owing to their poor growth only four trees of this clone were large enough to tap in July.

The family B. 84 × A. 44, which gave the highest yielding family of seedlings, also gives one of the highest yielding family of clones. B. 16 × A. 44 is also outstanding. There are insufficient budded trees in tapping to justify further analysis of the figures but on the whole the best-yielding families of seedlings have produced the highest-yielding clones.

The experimental material in Block 4 and 16 (legitimate seedlings and illegitimate seedlings derived from the Pilmoor clones and other promising parent clones) was established by Mr. L. E. Morris, (Geneticist at the Institute until his appointment was abolished 1932 on the decision to reduce the staff). Since his departure the maintenance and study of the material has been in the hands of Mr. C. E. T. Mann and Mr. K. N. Kaimal.

C. E. T. M. and K. N. K.

(4) Study of Seedlings derived from high-yielding Clones (Illegitimate or clonal Seedlings)

(a) *Yield of clonal Seeds*

From the area on Pilmoor Estate in which the artificial pollinations were made, illegitimate seed (only the female parent known) was collected of the same clones used as parents in crossing.

This was planted at the same time as the first and second series of crosses and all trees large enough were brought into tapping on 1st January. (R.R.I. Experiment Station, Blocks 4 and 16).

The yields obtained from the different families are set out in Table XVIII.

The chances of pollination by inferior clones in the experimental area on Pilmoor Estate or by the surrounding seedling rubber were considerable and the yields obtained, though superior to those that would normally be expected from ordinary unselected seedlings of the same age, are definitely lower than those obtained from the hand-pollinations made between known high-yielding parents.

In producing a family of illegitimate seedlings a number of different trees are used as pollen parents and the range of variation within each family is greater than in a family of legitimate seedlings. This is shown by the greater coefficient of variability compared with that found in the legitimate seedling families.

Although the highest-yielding families have been obtained by hand-pollination, some of the highest-yielding individual trees occur in the illegitimate families.

As would be expected from the results obtained from tapping the legitimate seedling families, the illegitimate seedlings of A. 44 and B. 84 are the highest-yielding families under test.

C. E. T. M. and K. N. K.

(b) *Variation within seedling Families*

To throw further light on the range of variability to be expected from clonal seedlings, seed from certain individual trees was planted at the same time as, and under very similar conditions to, the crosses and illegitimate seedlings in Block 4 of the R.R.I. Experiment Station.

All trees that had reached tappable size were tapped from 1st January 1935 on alternate days with a half-circumference left-to-right spiral cut. The yields obtained

TABLE XVIII. *Results of the first Year of Tapping of illegitimate Seedlings from Budding of the Pilmoor Clones (Clonal Seedlings)*

Block on R.R.I. Experiment Station	4					16 N					16 S				
Age at commencement of Tapping	5 Years 8 months					5 Years 5 months					5 Years 1 month				
Family	No. of trees	Mean Yield: gm. per tapping			V per cent	No. of trees	Mean Yield: gm. per tapping			V per cent	No. of trees	Mean Yield: gm. per tapping			V per cent
		Highest	Lowest	All trees			Highest	Lowest	All trees			Highest	Lowest	All trees	
A. 8	37	43.6	2.1	11.4	68										
A. 44	124	50.6	4.7	16.7	50	55	25.6	2.4	10.7	47	20	20.7	3.5	9.7	43
B. 58	62	35.5	3.0	13.5	52.5	58	29.2	2.3	8.5	56	9	18.5	3.3	8.7	
B. 84	13	33.6	4.5	16.7		132	54.1	0.9	11.7	60	10	19.0	3.9	7.9	
D. 61	22	24.1	3.9	12.1		44	31.3	3.5	9.4	62	1	—	—	7.2	
B. 16	3	9.7	7.3	7.8							18	17.9	2.9	7.7	47
B. 95	21	14.6	3.3	8.4											
B. 11	7	18.1	3.4	5.1											
B. 50						23	20.9	1.9	9.3	58					
D. 65											18	12.7	2.4	7.0	49
C. 72						9	16.2	3.2	9.1						
B. 90											9	12.8	3.1	4.7	

Note 1. The trees in Block 4 were tapped from 1st January, those in Block 16 from 1st April 1935.
Note 2. V = Coefficient of variability.

are shown in Table XIX and for comparison the coefficient of variability of each family found in the last period of test-tapping (July 1934) are included in the table.

TABLE XIX. *Variability in Yield during the first Year of Tapping (January—December 1935) of the illegitimate seedling Offspring of a single Tree*

Age in January 1935—6 years

Mother Tree	No. of trees tapped	Yield : gm per tree per tapping			Coefficient of variability	Test tapping	
		Mean	Lowest	Highest		No. of trees tapped	Coefficient of variability
Pilmoor A44/79	23	19.1	7.3	42.6	54.6	19	64.1
,, /81	44	20.6	4.2	44.7	55.2	35	46.1
,, /168	20	20.8	9.4	37.9	40.0	17	38.9
,, D61/700	65	16.4	3.7	34.5	44.8	45	54.0
Kuala Kangsar L	67	8.9	2.8	21.3	55.4	32	51.4

The coefficient of variability is a convenient measure for comparing the amount of variation obtained in the different families. The value of the coefficient is about equal to that recorded in Table XVIII and, although higher than that of legitimate seedling families, is lower than would be found in a planting of unselected seedlings.

C. E. T. M. and K. N. K.

(c) *Seedlings from isolated Seed Gardens*

(i) Control rows in R.R.I. Experiment Station, Blocks 9A and 20A were budded with Prang Besar 186.

To compare the effect of budding clone and seedling with the parent clone and with "foreign" clones, the rows in Blocks 1A and 16F were budded in sequence with Clones AVROS 49, 157, Prang Besar 25 and Bodjong Datar 5.

(ii) A number of seedling trees obtained from the Tjikadoe isolated Seed Garden were planted as stumps in October 1928 and were tapped throughout the year (R.R.I. Experiment Station, Block 2).

There were originally twenty five clones in the Tjikadoe Seed Garden and the seeds were sorted into the twenty five clonal types before planting.

The mean yield of all the trees was 15.6 gms. per tapping but the variation in yield of the different families was considerable. (Table XX). Types 10, 20 and 21 give yields considerably higher than the average.

A second consignment of seed from the same source planted in baskets in October 1929 gave a mean yield of 11.2 gms. per tapping.

C. E. T. M., C. C. T. S. and K. N. K.

TABLE XX. *Yield of Tjikadoe seedling Trees. January—December 1935*

Clonal Type	Planted as stumps, October 1928		
	No. of Trees tapped	Mean Yield per Tree per Tapping (gm.)	Lowest & Highest Tree Yields (gm.)
1	9	18.7	2.9 — 38.2
2	13	19.8	7.2 — 40.8
3	9	11.4	3.7 — 28.4
4	8	9.2	3.6 — 16.8
5	10	8.2	3.8 — 13.3
6	8	17.9	7.4 — 42.4
7	12	18.5	4.6 — 38.2
8	9	10.7	7.1 — 15.2
9	4	15.4	4.4 — 23.2
10	10	27.2	5.9 — 83.6
11	10	9.6	2.4 — 20.0
12	7	12.8	7.9 — 30.0
13	6	15.5	9.8 — 25.7
14	6	11.6	7.8 — 17.8
15	14	19.8	5.1 — 44.9
16	4	10.2	3.6 — 19.4
17	9	23.9	8.0 — 46.9
18	10	12.3	6.5 — 31.5
19	12	13.1	5.1 — 26.4
20	15	26.1	3.0 — 62.6
21	6	32.0	8.0 — 39.3
22	9	16.0	6.8 — 39.2
23	9	14.7	3.4 — 47.6
24	9	15.6	5.3 — 28.0
25	7	8.7	3.8 — 21.4
Total and Mean	225	15.6	

(d) *Seedlings from Buddings of Proved Clones in commercial Planting*

Two further areas (R.R.I. Experiment Station, Blocks 28 and 29) were planted with seedlings of Clones Pilmoor B. 84, AVROS 256, Tjirandji 1 and Prang Besar 23. Part of these seedlings will be budded during 1936 and part will be left unbudded.

C. E. T. M., C. C. T. S. and K. N. K.

(5) Methods of Test-tapping and their Value in selecting and thinning in Seedling Plantations

(a) *Different Methods of Test-tapping young Seedling Trees*

The trees which had been test-tapped from the age of 3 years for short periods at intervals of six months were brought into regular tapping alternate-daily on a half-circumference cut on 1st January (R.R.I. Experiment Station, Block 2).* The correlation between the yield on regular tapping with the yield in the various periods of test-tapping are set out in Table XXI.

Table XXI. *Correlations of the Yields of individual Trees during the first Year of Tapping with the Yields of the second five days of successive Periods of Test-tapping*

Tapping System	Period Date Age	1st Jan. 1932 3¼ years	2nd July 1932 3¾ years	3rd Jan. 1933 4¼ years	4th July 1933 4¾ years	5th Jan. 1934 5¼ years	6th July 1934 5¾ years
A.D.	for 30 days	+ 0.56	+ 0.73	+ 0.82	+ 0.85	+ 0.84	+ 0.83
Daily	for 30 days	+ 0.77	+ 0.82	+ 0.87	+ 0.87	+ 0.85	+ 0.85
Daily	for 15 days	+ 0.77	+ 0.75	+ 0.85	+ 0.83	+ 0.80	+ 0.85

All tapping cuts were on a half-circumference.

It is clear that in the first periods of test-tapping a more reliable indication of the future yields of the individual trees is obtained from daily than from alternate-daily tapping.

* *Annual Report R.R.I. of Malaya* (1932) 84; (1933) 98; (1934) 88.

It can also be seen that no greater reliability is obtained by postponing the time of test-tapping until the trees are over 4¼ years of age.

C. E. T. M. and K. N. K.

(b) *Nursery Selection with Cramer's Knife*

Block 14, Section E.1 of the Experiment Station was planted with clonal seedlings selected in the nursery with "Cramer's Knife" in November 1931.*

The seedlings were classified according to the length of flow of the latex into three equal groups A, B and C, having a good, fair and poor flow of latex.

Half the seedlings were budded in 1932. The unbudded seedling trees were test-tapped in December for ten consecutive days. The yields for the last five tappings were recorded and the results are tabulated below (Table XXII). Eighty-five per cent of the trees were tapped.

TABLE XXII. *Test-tapping of Seedlings selected on Nursery Test*

Type of Seedlings	No. of Trees	Mean yield.			
		Group A	Group B	Group C	All Groups
A.44	86	48.1	34.3	33.2	38.5
B.50	105	30.7	35.3	32.0	32.7
B.58	145	36.3	30.8	27.7	31.5
M.A.P.	95	19.1	20.8	18.2	19.3

The results show considerable difference between the clones. The best results are obtained from seedlings of A. 44 which has already shown itself to be a producer of high-yielding illegitimate seedlings.

Permanent records of the nursery tests have been made and the test-tapping results will be subjected to further analysis.

* *Annual Report, R.R.I. of Malaya* (1931) 69.

It should be mentioned that there is evidence of a great deal of variation in the yields within each group.

C. C. T. S.

IV. Indigenous Cover Plants in Rubber Cultivation: Ecological Studies.

Block 27. (50 acres)

This experiment is described in detail in the Annual Report 1934 pp. 90 and 148.

The centre sub-plot of each of the three treatments involving the use of natural covers has been selected for an ecological survey. Since there are five replications of each treatment, there are fifteen sub-plots undergoing detailed observation.

Belt transects are permanently marked out along the diagonal of each of the fifteen sub-plots with strands of fencing wire, each belt being 20 feet wide and 186 feet long.

Detailed charts of the occurrence of the different plant species were made in June and December 1935. Further charts will be made at intervals of six months.

From an examination of the charts the following general observations can be made.

(1) Plants first appear and grow more vigorously amidst and around the timber and brush wood piled between contours (probably because they provide shade and help to retain moisture in the soil).

(2) About 90 species of plants have so far been found growing in the selected area showing the multiplicity of indigenous species occurring in forest clearings and the magnitude of work necessary for an ecological study of this nature.

(3) The dominant indigenous species are enumerated in their order of dominance.

Ephemeral herbaceous type

Erechthites valerianifolia
Erigeron sumatrense
Emilia sonchifolia
Ageratum conyzoides

Giant herb type

? Globba sp.

Grasses

Paspalum conjugatum
Digitania longiflora

Ferns

Nephrolepis biserrata
Ceropteris calomelanos

Shrubby or small tree type

Trema angustifolia
Trema amboinensis

(4) Trema species die out by slashing at 3 ft. especially the larger species *Trema amboinensis.*
(5) The other two plots in each block were allotted to creeping and bushy leguminous covers. It has been observed that, among the leguminous creeping covers, *Pueraria phaseoloides* is dominant and checks the spread of *Calopogonium mucunoides* and *Centrosema pubescens. Crotalaria anagyroides* and *Tephrosia candida* among the bushy types have become well established and seem almost full grown while *Leucaena glauca,* in most cases, has not grown more than one foot in height.

K. N. K.

Field Experiments on R.R.I. Experiment Station, Sungei Buloh

The undermentioned additions are made to the Schedule of field experiments published in previous Annual Reports.*

Block No.	*Acreage*	*Description of Experiment*	*Date of Commencement*
5A	2½	Cleared of secondary jungle and planted for testing new clones.	November 1935
17B	2¾	Clone trial Experiment.	October 1935
28 29	12.8	To test the value of four types of clonal seed.	October 1935
30	40	Cleared of jungle and prepared for testing new clones.	March 1935

**Annual Report R.R.I. of Malaya* (1932) 87-90; (1933) 101-102; (1934) 91.

Advisory Work

Correspondence

A detailed analysis of the correspondence will be found in an Appendix to the Director's Report. There was an increase in the total volume of correspondence of 27 per cent. This increase can be allocated to three principal headings—advice on the choice of clones, mostly for replanting; advice on replanting, and the planting of experimental areas on estates permitted by the Rubber Regulation Scheme.

Estate Visits

The visits paid by members of the staff for advisory and research work are enumerated below.

Member of Staff	*Advisory visits*	*Research visits*
C.E.T.Mann	47	34
C.C.T.Sharp	23	48
H.Gunnery	—	3
K.N.Kaimal	—	88
T.V.Vaidyanathan	—	37
	70	210

Interviews and Visitors

During the year 85 visitors were interviewed compared with 78 during 1934. The visitors were mostly estate managers or agents and the bulk of the subjects discussed were connected with replanting or with the planting of experimental areas on estates.

Lectures

Mr. C. E. T. Mann to the Rantau—Port Dickson Branch of the Incorporated Society of Planters.

Publications

(1) "Yield Prediction in Hevea" by H. Gunnery
R.R.I. Journal Vol. 6, No. 1

(2) "Recent Progress in the Selection of Planting Material" by C. E. T. Mann
R.R.I. Journal Vol. 6, No. 1

(3) Experiments with Economic Tapping Systems (i) Part III
by C. C. T. Sharp
R.R.I. Journal Vol. 6, No. 2

C. C. T. Sharp

Acting Senior Officer, Botanical Division

Kuala Lumpur

March, 1936

ANNUAL REPORT

PATHOLOGICAL DIVISION

Staff

At the end of 1934 Mr. R. P. N. Napper proceeded to England on long leave for 12 months so that the writer remained the only European Officer in the Division throughout the year. Mr. Napper resumed duties on December 27th 1935.

The post of Asiatic Graduate Assistant in this Division was taken up in July by Mr. D. V. Daran, PH.D. (London), B.A., (Madras) but this officer resigned at the end of the year.

Mr. Hoh Choo Chuan, Draftsman gave sterling service.

The Asiatic junior staff also continued to give valuable assistance.

Research

The demands on the time of the remaining European Officer for routine correspondence and advisory work curtailed research although certain lines of work have yielded interesting results which are reported under the various disease subject headings below.

Owing to the fact that we have been unable yet to obtain a cool incubator of the required type, the laboratory work on *Oidium Heveae* had to be abandoned. Negotiations have been in progress with an American firm as a result of which it is hoped that a suitable incubator can be obtained so that this and similar work at low temperatures can be carried out in the near future.

Lack of staff both in the Chemical Division and the Pathological Division resulted in a temporary stoppage of the work on latex bacteriology during the greater part of the year.

In April work was commenced on the bacteriology of rubber estate soils to determine what improvement occurs in the bacterial flora as a result of various forms of manuring and of the introduction of natural covers on clean-weeded soils. Interesting results are already available showing a seasonal effect as well as a more permanent effect by manuring on numbers of bacteria in the soil.

The problem of replanting of uneconomic rubber areas has received considerable attention during the year and in order to obtain as much information as possible on this subject a questionnaire was circulated to some 96 estates which were on our list as having done or contemplated replanting. The number of replies received and the information contained do not justify the publication of the results.

Root Diseases

With the return to improved conditions following the depression, increased attention is now being paid to field work particularly the prevention of the spread of root diseases of the rubber tree and regeneration of tree stand in the spaces caused by the death of trees from such diseases.

It is now recognised that, in areas of young rubber, eradication of the root parasites derived from the originally infected jungle is a simple and economical estate practice. The early routine inspection of all trees in the second year of life serves to indicate the disease patches while still small and the source of infection in the jungle timber can be traced and removed. In this way *Fomes lignosus* should be completely eradicated by the fourth or fifth year of life of the plantation.

In the case of the slower acting fungi *Ganoderma pseudoferreum* and *Fomes noxius* a few years more will be required before all latent infection can be traced.

The problem of the economical control of root diseases in old rubber is, however, more difficult of solution and it is often difficult to decide whether it is better to treat individual patches or to leave the area alone pending mass treatment by digging over and removing all buried roots and timber with a view to replanting the area with high-yielding strains of rubber.

On many areas of old rubber examined during the year it could well be said that the latter scheme would be the more economical and give the best results. On many of the inland hilly areas the vacant spaces caused by the red root disease fungus *Ganoderma pseudoferreum* are so numerous and of such a size that the disease patches could be said to be coalescing and that the greater percentage of trees were either diseased or were in the early stages of infection. Mass treatment, combined with contour terracing preparatory to replanting, appears to be the only economic course to adopt in such cases.

In rubber of medium age and of which a considerable number of years of economic production are expected the isolation of disease patches by trenching is usually recommended and at the same time the tracing and removal of infected jungle timber is to be considered. The saving of trees within the trenched area by amputation of diseased roots is also practicable providing the disease has not passed into the bole of the tree.

From the point of view of the estate it can generally be said that the root diseases are the primary cause of depletion of stand of trees and consequently reduction of crop. It is therefore essential that due attention should be paid to the removal of the root disease menace as early as possible in the life of the plantation.

Throughout the year a considerable number of root disease control experiments have been in progress on estates and will be reported upon later by Mr. Napper.

The use of copper sulphate or other soil fungicides is no longer recommended as a means of controlling root disease fungi.

The problem of root diseases in areas where natural forest cover plants have been allowed to develop or where leguminous bush covers have been planted is not generally understood and it might be stated here that woody plants, by breaking up the rhizomorph system of the root disease fungi tend to retard the rate of spread and are said to have a "buffering" action. In young rubber areas such covers, being themselves susceptible to attack by these fungi, tend to indicate the presence and extent of infected areas so that suitable measures can at once be taken to eradicate the disease which would normally not have shown up until considerably later.

Ustulina zonata

This disease which may frequently be found attacking the collar of rubber trees as a result of the accumulation of putrefactive scrap rubber at the soil surface is frequently confused with the true root disease fungi and is responsible for depletion of stand in some rubber estates to a far greater extent than might at first be thought. This disease is very different in action and mode of spread than any of the three true root disease fungi. Wind-borne spores and contact of diseased wood at a wound are the chief means of infection of rubber trees and therefore in considering replanting there can be little danger of this disease affecting the new young crop. If a note is made of tree vacancies in the old stand caused by this disease considerable economies in trenching and digging over can be made.

Replanting and Diseases of Rubber

Many enquiries have been received during the year on the subject of control of diseases in young replanted rubber and in areas about to be replanted.

In view of the fact that in most cases the chief reason for replanting has been depletion of stand by root diseases these diseases and the problem of their eradication during the felling and replanting process have been the chief subject of consideration.

In the coastal peat soils and inland river flats *Fomes lignosus* is the main fungus concerned in the diseases of the roots of the old stand. In many such areas the fungus appears to have reached a dormant state and the closest external examination of roots of the old trees fails to reveal the white rhizomorphs though fre-

quently internal discolouration of the wood indicates suspicion of the presence of disease organisms. Extreme care therefore has to be exercised when replanting such areas to ensure that buried roots or undecomposed jungle timber are removed before replanting.

On the inland undulating areas most of the root disease patches are caused by the red root disease fungus *Ganoderma pseudoferreum*. This disease is much slower in action than *Fomes lignosus* and in fact, when attacking a tree, it appears to have a resting period following each three or four years' activity. During this resting period, which may last for several years, the rubber tree regenerates new roots to take the place of the old rotted one, in many cases entirely masking the disease when the roots are pulled out during felling operations.

Brown Root disease caused by *Fomes noxius* is comparatively rare except in certain areas of white sandy or alluvial soils and for present purposes may be considered in the same class as Ganoderma.

In regard to the aerial portions of the tree it is unlikely that any of the diseases to which these portions are susceptible will be a menace to the new crop and therefore the stem and branches of the trees may be piled between rows or on contour on hilly land and allowed to rot, thus contributing their proportion of humus to the general fertility of the soil.

In the root disease areas it is necessary to dig over the soil and remove all buried rubber roots and undecomposed jungle timber. This is particularly important in peat lands where the rhizomorphs of *Fomes lignosus* are apt to spread rapidly along the non-resistant, inter-grafted mesh of lateral roots.

If, however, little attention has been paid to the control of root diseases in the past, so that disease patches have coalesced, the whole area will have to be treated as one large disease patch and all likely infective material removed from the soil to a depth of two feet. Careful supervision of the digging is of great importance to ensure that all infective material is removed and to see that an effort is made to retain the topsoil on the top behind the advancing trench.

Areas which have been replanted without special attention to root disease eradication should be subject to regular root inspection in order to trace and remove the source of infection as early as possible.

Bush covers which are susceptible to root disease may be planted to serve as indicators of the location of diseased timber missed during the digging process.

The occurrence of Pink disease in bush covers is discussed later in this report.

Diseases of the Tapping Panel

Mouldy Rot (*Ceratostomella fimbriata*)

During the long period of hot dry weather at the beginning of the year very few enquiries were received in regard to this disease, but throughout the second half of the year considerable difficulty was experienced by many planters in getting the disease under control owing to the continuous wet weather which, though with few really heavy rains, has been devoid of those short spells of intervening fine weather which serve to dry the bark of the trees and which are so necessary now that natural covers are becoming comparatively dense.

There have been no changes in the methods for treatment of this disease and the official list of fungicides approved for the purpose remains the same as published in the Annual Report 1933, p. 133.

During the year many preparations have been tested for suitability for a place on the "White list" of approved fungicides, but none have as yet been found satisfactory in the field.

One preparation of interest consists of a mixture of 10 per cent "Izal oil" in locally produced Palm oil. This mixture has so far given good results, showing adequate control of the disease combined with a beneficial effect upon bark renewal and latex flow from the renewed bark.

Tests of fungicides are usually conducted on areas of small-holding rubber trees where the degree of infection is almost 100 per cent. Owing to restriction of production many small-holders preferred to stop tapping and instead to derive an easy income from the sale of coupons. The result has been that considerable difficulty has been experienced in obtaining suitable continuously tapped areas in which to carry out our field tests of proprietary fungicides.

Brown Bast

The problem of "Dry" trees continues to give considerable anxiety on many estates, particularly in areas of closely-planted young trees newly opened to tapping tests preparatory to thinning out. If left to carry on, the latex vessel system dies and gummation of the neighbouring cells followed by meristematic activity soon leads to the typical symptoms of Brown Bast. Preventive measures were described in the Annual Report 1934, p. 100 and in a circular issued by this Division.

Black Stripe and Patch Canker (*Phytophthora sp.*)

In regard to this disease there is little difference in the situation from last year except that in the more northern districts the

weather following refoliation caused a considerable incidence of these diseases together with the appearance of isolated cases of Phytophthora Pod Rot of the fruit.

Black Stripe responds easily to treatment with water-miscible fungicides of the tar oil emulsion type, especially if the disease is diagnosed in the early stages.

White Fan Blight (*Marasmius sp.*)

The wet weather of the middle and later parts of the year caused a considerable increase in incidence of this comparatively mild disease of the tapping panel. This disease appears in wet weather as a white, silky mycelium easily visible to the naked eye and spreading fan-wise over the surface of the tapped bark to which, though penetration is very slight, it is closely adpressed. The fungus usually commences growth from the corners of the extremities of the tapped panel, where the moist dead scaling tissues seem to be favourable to the growth of the fungus.

It is an extremely weak surface-growing parasite and should cause little alarm in that it quickly responds to treatment with a weak mixture in water (say 5 to 10 per cent) of any of the tar acid emulsions used for Mouldy Rot, *e.g.* Killgerm, Brunolinum plantarium and Agrisol.

Unknown Bark Canker

A new and previously unencountered bark canker has been reported from the Institute Experiment Station at Sungei Buloh on 5 year-old budded trees and on two 6 year-old seedling trees. The canker is illustrated in Plates I, II and III.

Investigations have failed to reveal the presence of any parasitic organisms and it is suspected that the abnormality is due to some physiological disturbance in the bark. The canker appears on stem and branches as vertical cracks in the bark over a circular patch from which a little latex may flow and coagulate.

On investigation it appears that meristematic activity is set up in the outer cortical tissue which results in the development of plate-like tissue similar to that which occurs in shallow seated Brown Bast. Hence the glazed appearance of the underside of the plates of tissue which can be pealed off. This meristematic activity is probably responsible for the splitting of the bark with resultant exudation of latex.

The treatment suggested is to scrape off the affected bark down to healthy cortex.

In this connection it is interesting to note that the Director of the A.V.R.O.S. Proefstation, Sumatra, informs us that he has

PLATE 1.

PLATE 2.

PLATE 3.

met with a similar unknown canker together with a further canker which appears to be distinct from the above.

Branch Diseases

Pink Disease (*Corticium salmonicolor*)

The situation in regard to this disease remains similar to last year. The early period of fine weather reduced the incidence of this disease in young trees which had been so noticeable in the wetter wintering season of 1934.

The appearance of Pink Disease in bush covers such as *Crotalaria sp.* has caused considerable alarm, though this can be avoided if sufficiently wide rentises are left in which the rubber trees can get ample sun and air.

However beneficial bush covers may be they should never be planted so thickly or so close to the young rubber trees as to make it difficult even to find the rubber trees, as is the case in a number of young clearings which the writer has visited.

Ustulina zonata in the Stem

In the coastal districts where, owing to the leaning of the trees, wind splits are of frequent occurrence this disease is constantly to be found. Early treatment of such stem damage and all pruning wounds and the burning of infected portions of trees blown down is necessary for the control of this disease.

The pruning of old 'hat pegs' on trees is to be deprecated since the old scar, being already protected by an efficient gum layer, is practically proof against the entry of disease fungi.

The formation of 'hat pegs' in young trees however can be avoided by a little judicious pruning—usually carried out by the Pink Disease gang—of unwanted lower and inner branches of the trees especially between the ages of four and seven years. Many of the more vigorous clones are very slow in throwing off their unwanted branches and consequently a thick collar of support is produced which, when the unwanted branch eventually does fall, becomes the hollow 'hat peg' of later years. At the time of fall of such branches there is a danger of infection by Ustulina but within a few months a protective gum layer is laid down.

Rusts of Leguminous Bush Covers

Reports have been received during the year of considerable losses in bush covers due to a fungus of the group *Uridinales*. The orange-coloured circular pustules appear suddenly on leaf, stem and flowers of the bush covers eventually killing the plant back to the main stem. Young plants may be entirely killed.

In two instances in Malacca where *Tephrosia Vogelii* and *Tephrosia candida* were planted together, both were attacked by rust while quite young during rainy weather. In Kedah a case was reported where the above species of bush covers together with *Crotalaria anagyroides* were planted in the same field and only the Crotalaria became attacked by rust on reaching maturity and flowering time just after the rainy season.

The Uridiniospores (Uredospores) have been found on both Tephrosia and Crotalaria and these appear so similar that, until further data is available, they will be regarded as identical. No second host, bearing spore types O & I, have yet been found.

The Uredo sori are more or less circular, 1 to 2 mm. in diameter and orange in colour and are found on green or flowering parts. They may be so numerous as to coalesce giving the appearance of an orange pink stem. The Uridiniospores produced in great numbers are spherical, about 18μ in diameter, and of a pale pinkish-brown colour.

Until the discovery of a second host the only means of control is to keep a close watch on the area and carefully to prune off and burn the diseased stems as soon as possible.

Leaf Diseases

Leaf Mildew—*Oidium Heveæ*

During the early part of 1935 Malaya experienced a return to more normal weather conditions. The easterly winds following the north-east monsoon rains produced a period of very bright, dry weather during most of January and the first half of the month of February. A period of drought coming at this early part of the year is ideal from the point of view of inducing the fall of old leaves and production of new foliage—a natural function observed in all deciduous trees, even in tropical regions, and known locally in connection with rubber trees as "wintering".

TABLE I

Rainfall in Inches for 1935

District	Jan.	Feb.	March	April	May	Total
Kuala Lumpur (S) ...	4.77	11.85	9.95	13.00	6.71	46.28
Sitiawan (Pk) ...	9.17	2.70	4.83	6.40	4.66	27.76
Port Dickson (N.S.) ...	5.32	1.66	4.04	9.12	—	20.14
Tampin (N.S.) ...	1.93	4.56	8.47	6.30	—	21.26
Malacca (S.S.) ...	2.59	4.74	3.38	5.01	8.90	24.62
Kluang (J) ...	4.77	6.18	7.14	8.83	10.55	37.47

As a consequence of this pronounced period of dry weather wintering was early in practically every part of the country, the exceptions being some local coastal areas, especially the Dindings and Matang in Perak where local weather conditions appear to be affected by the close proximity of the Hijau and Bubu mountains, and the Labu- Port Dickson district in Negri Sembilan where again local weather is affected by nearby mountains. The earlier reports of the presence of the disease were received from these districts. "Wintering" generally was sharp and even while, in the northern districts, refoliation was almost complete before the weather broke. In the central and southern States up to 50 per cent of the trees had obtained their new leaves by the middle of February and it was thought that Malaya would escape Leaf Mildew disease entirely. However, on the 14th February a distinct change in the direction of wind occurred and several dull cloudy days with light rains followed, giving opportunity for the fungus to develop and attack the young leaves of the late-wintering trees.

This dull weather continued for several weeks but intervals of bright sunny weather speeded up the refoliation and prevented the disease from attaining a virulency sufficient to cause serious defoliation.

Table I shows the rainfall for the first five months of the year. A dry period covering at least two of these five months can be noted in each of the districts mentioned.

A summary of the report on this disease, quoted from the Journal Vol. 6, No. 1, reads as follows:—

"The fine dry weather experienced during January and "February induced an early wintering of rubber trees in Malaya "with the result that a large percentage of the trees had obtained "a good healthy crown of foliage before the break of the weather "and advent of conditions more suitable to the mildew disease.

"The foliage and seed harvest this year are a great improve-"ment on the last few years.

"Only in isolated localities has the fungus caused a mild leaf-"fall, usually found to be due to differences in local climatic con-"ditions caused by the proximity of mountains.

"The great benefits to be derived from a dry, sunny wintering "season are indicated by the improvement in both health and den-"sity of foliage of rubber trees as a result of the present year's "experience.

Manured areas owing to the later wintering thereby induced suffered more from Oidium this year than unmanured areas.

Sulphur Dusting in Control of Oidium Heveae

As a consequence of the early wintering and rapid refoliation sulphur-dusting was commenced about the middle of February and in many cases estates were advised that about three rounds of dusting, instead of the usual five or six would be sufficient to protect the foliage from disease. In many cases this advice was carried out and proved to be a justifiable economy.

In the majority of cases there was little noticeable difference in foliage or yield between dusted areas and control (undusted) areas owing to the very mild attack.

In conjunction with the officers of the Agricultural Advisory Branch of Imperial Chemical Industries (Malaya) Ltd., a suitable dusting-sulphur has been produced by the admixture of a protective agent with the locally-produced Java sulphurs. These sulphurs had the disadvantage of being deliquescent and on storage became wet causing aggregation with consequent very poor dusting properties. The new powder known as Cirrus Dust is still cheaper than other imported brands and has satisfactorily withstood storage for a period of one year. Arrangements have been made for manufacture so that Cirrus Dust is now available in commercial quantities throughout the east.

Malayan Fertilisers Ltd. have also produced a satisfactory dust named "Star Brand" Sulphur Dust which should shortly be available in commercial quantities.

Insect and Other Pests

Hevea Thrips—A New Pest of the Rubber Tree

In March what was thought to be a rather severe outbreak of Oidium on the Institute Experiment Station was brought to our notice. It proved, however, to be a case of infestation by an insect identified as Thrips sp.

The infestation results in symptoms somewhat like that of Oidium—indeed the two were often found together. The young leaf, only a few days old, is strongly favoured by the insects and leaves may fall before they attain a length of two inches. The insect appears to feed chiefly in the region of the veins on the *underside of the leaf only.*

The growth of the tissues on the underside of the leaf is retarded while the upper surface continues to grow at a faster rate resulting in the leaf becoming very concave on the underside. If the leaf survives for about three weeks it assumes the shape of a scoop, the concave side being below, which is exactly the reverse of a leaf surviving an Oidium attack.

Thrips infested leaves which have fallen to the ground may be distinguished by the prominent brown or black veins, the colour being due to early decomposition of the punctured cells of the veins.

The intensity of attack appears to depend upon the number of young leaves present and the state of the wintering refoliation. Areas were observed where three and four-acre groups of trees wintering simultaneously had suffered a very heavy attack resulting in a complete defoliation of the trees such as is rarely seen, except in individual trees in the case of Oidium. Light rains following a fine spell appear to favour the activity of these insects.

The application of insecticidal dusts by means of a motor duster gave satisfactory control (See Report, R.R.I. Journal Vol. 6. No. 1, p. 60).

Spider and Mites

These insects in close association continue to cause considerable damage to the young leaf of nursery plants and trees up to several years of age. The tip of the leaf becomes blackened and ragged while the common leaf-spot fungi produce circular lesions on the otherwise undamaged basal portion of the leaf.

Dusting with sulphur about every fourth day greatly reduces the severity of attack and should be carried out in young areas of valuable material.

White Ants (*Coptotermes curvignathus*)

This pest continues to give trouble in many Malayan rubber plantations. The use of a fumigant and a poison dust in combination is finding more favour with managers and, if carried out in the proper manner, gives a fair degree of control.

The Cockchafer Grub (*Psilopholis grandis*)

During the year six new centres of infection have been reported but in no case has serious damage to the rubber trees taken place, although natural covers and grasses have had their root systems eaten away so that affected areas have the appearance of having been miraculously withered.

The new affected areas are distributed from Singapore island to Province Wellesley, indeed, if carefully looked for, these grubs or like species may be found in almost every garden soil throughout the country.

The areas previously reported as infested cannot be said to have enlarged for it would appear that the adult beetles will not wander far away from jungle while natural predators of the Scoliid wasp type appear to harass the grubs sufficiently to prevent any widespread migration.

The life history together with a description of known parasites and hyperparasites was published in the R.R.I. Annual Report 1934 pp. 106-107.

Further experiments under the auspices of local chemical firms have failed to produce a means of direct chemical control.

Caterpillars

Owing to the prevalence of natural covers throughout most rubber areas the number of enquiries in regard to caterpillars is increasing. The association of caterpillars and grasses is strong and, if grasses are to grow too thickly, the pests may become so numerous as to cause the tappers to refuse to work in that particular area. The nettle grub such as *Thosea Sinensis* described in R.R.I. Annual Report 1933, p. 116 is especially fond of grasses. These grubs or caterpillars bear poisonous spines which cause irritating wounds on the legs of labourers coming into contact with them. The hairy caterpillars of the family Lymantriidae are of frequent occurrence and some of them may be observed causing wounds on the inner cortex of the freshly tapped panel. A spray with an insecticide may usefully be applied to prevent excessive wounding of the renewing bark.

So far it has not been necessary to adopt special control measures over extensive areas since the outbreaks have been of a local and temporary nature.

On the Institute Experiment Station, Sungei Buloh, an outbreak of caterpillars on Block 27 caused a complete defoliation of all natural covers and other jungle growths over an area of several acres. Even the thick-leaved wild ginger plants were eaten so that only the coarse middle vein of the leaf was left. This caterpillar proved to be of the "Cutworm" type belonging to the family *Noctuidae*. The pest was eventually controlled by spraying at weekly intervals with a 1 per cent Lead arsenate-kerosene emulsion.

Beetles

Various small beetles are reported as attacking jungle growths, leguminous covers and also occasionally the freshly-tapped bark. These are not of great importance and can be prevented from attacking the rubber trees by an occasional application of a weak solution of any of the products mentioned in the list of approved fungicides for control of Mouldy Rot.

Snails

The giant snail, which is now distributed throughout the country, has on several occasions been reported as causing damage

on young rubber trees, though more frequently a small slug is the chief offender.

Chemical methods of control do not appear to be very successful, and the clearing up of likely breeding places combined with hand collection and destruction of adults is the only satisfactory means of minimising the damage.

Rodents

As described in the Annual Report 1934, p. 109, rats, squirrels and porcupines are occasionally reported as causing damage to young rubber trees and the newly-tapped panel of older trees but the damage is usually slight.

For protection of young trees the poison bait method appears to meet with little success in some cases. The most satisfactory method is to protect the plants by a wire netting cylinder placed round them until mature brown bark has formed on the lower one foot of the seedling stem.

Hunting porcupines and destruction of their breeding places will effectually eliminate or drive away this pest.

Bacteriology of Latex

Owing to the shortage of staff only the more urgent routine work on latex preservation has been executed during the year so that there is little new information available.

Seasonal changes in rate of natural coagulation and rate of increase in number of organisms in fresh latex are now recognised. During the wintering season, when premature coagulation causes trouble on estates, the actual number of organisms at the time of flocculation is only a fraction of those found at the same stage at other times of the year. It would seem therefore that this seasonal premature coagulation of latex is due to some inherent factor in the latex produced during the shedding of old leaf and growth of new foliage rather than to more rapid development of bacteria in the latex which might be expected during the hot dry season usual at that time of the year.

The addition to the field latex of sodium sulphite during the wintering season therefore may be looked upon as serving the purpose of an anti-coagulant rather than that of a preservative.

Among the preservatives for latex tried during the year Azochloramide is of interest. Azochloramide is a bactericide of recent invention and is effective in very great dilution even in the presence of protein in the medium and is finding wide use in the preparation of blood serum vaccines.

It was found, however, that the inhibition of growth of bacteria in latex by this chemical was but slight and that the presence of ammonia was required to prevent premature coagulation and to give the bactericide time to act. As a result of this work it was concluded that Azochloramide cannot be used alone as a preservative of latex owing to its strong tendency to coagulate the latex particularly if added in the solid form.

Its comparative insolubility in water renders it difficult to add the preservative in sufficient strength without considerably diluting the latex, while it is unfortunate that the great majority of solvents of Azochloramide are themselves either coagulants or solvents of the rubber phase or both and therefore cannot be used in latex.

Fresh latex allowed to coagulate and stand for the same time under the same conditions becomes a mass of dry rubber with no fluid portion.

Bacteriology of Soils

During the year an attempt has been made to investigate the change in numbers in bacteria which may take place in Malayan soils following the application of various types of manures and also the adoption of natural forest covers after a long period of clean weeding.

Among the 36 samples taken each month are representative types of coastal peat, river flat clays and laterite hill soils and already considerable useful information has come to hand.

In accordance with the writer's previous experience the medium used for the soil bacterial analysis has been D.I.F.C.O. Bacto Dextrose Agar which gives a much higher count and truer idea of the soil flora than does Thorton's medium. On Dextrose Agar, both bacteria and the microfungi—Actinomycetes—grow well and both can conveniently be counted after 4 days' incubation at room temperature in Malaya, *i.e.* 26°C — 31°C.

Whereas Dr. Corbet in his book "Biological Processes in Tropical Soils" using Thorton's medium reports counts of tens or hundreds of thousands of organisms per gramme of soil, with Dextrose Agar millions and tens of millions are usually found in the upper layers of soil. The Actinomyces sp. which are an important factor in soil fertility are almost inhibited by the synthetic medium but are shown to be present in hundred thousands and even millions per gramme of soil by the Dextrose Agar medium. Dr. Thornton in the Rothamsted Annual Report 1934, p. 58 himself suggests that the numbers of bacteria found in soil by direct microscopic methods are of the order of one hundred fold those found by plate counts using the synthetic medium.

The counts so far have both seasonal fluctuation in numbers and increase in numbers as a result of the use of certain manures and natural covers. The bacterial examination will continue throughout 1936 after which sufficient data should be available for the publication of a full report.

Lectures

A lecture on "Diseases of Hevea in Relation to Replanting" was given before the Malacca Planters' Association at Malacca.

Publications

The following publications and circulars were prepared and issued.

(1)	Annual Report 1934	by F. Beeley
(2)	Report on the 1935 Outbreak of *Oidium Heveae*, R. R. I. Journal, Vol. 6, No. 1.	,,
(3)	Hevea Thrips—A Note on a new Pest of *Hevea brasiliensis*	,,
(4)	Identification of Root Disease in the Field	
(5)	Stinking Rot of Roots—*Sphaerostilbe repens*	,,
(6)	Pink Disease—*Corticium salmonicolor*	,,
(7)	Patch or Claret Coloured Canker—*Phytophthora* sp.	,,
(8)	Hevea Leaf Mildew	
(9)	Termites. The White Ant Pest of Hevea	,,
(10)	*Ustulina zonata*—A white Rot of Stem and Roots of Hevea	,,
(11)	Fire Damage—Heat and sun scorch of the tapping Panel and Seedlings.	
(12)	Thrips and Mites, Pests of Hevea	
(13)	Black Stripe Disease of the tapping Panel	,,
(14)	Slugs and Snails—The Mollusca	,,
(15)	Minor Leaf Diseases of Hevea	,,

Visits and Interviews

Visits to Estates	57
Interviews	65

Samples Examined

The following is a list of samples received from estates and examined.

Leaves	99
Roots	20
Cover Plants	8

Bark	20
Stumps	5
Wood	6
Branches	6
Scraps	1
Seeds	1
Fructifications	2
Insects	10
Fungicides & Insecticides	14
Soil	241
Total	433

The soils consisted of samples from estates for bacteriological investigations in connection with experimental work on the improvement of soils by manuring and development of cover plants.

Tours

The following special tours were made:—

(1) Negri Sembilan, Malacca and Johore in connection with Oidium leaf disease.

(2) Perak and Kedah in connection with Oidium leaf disease.

(3) Perak in connection with Root diseases.

F. Beeley

Pathologist

ANNUAL REPORT

CHEMICAL DIVISION

Staff

During the greater part of the year the staff has been below strength and for a period of approximately six months, when the Senior Officer was on furlough, Mr. Hastings was the only research officer available. Research activities have therefore of necessity been very restricted. The strength was increased in the second half of the year when two newly-appointed officers Mr. J. H. Piddlesden and Dr. K. C. Roberts arrived in Malaya in July and August respectively and assumed duty. The Senior Officer returned from leave in September and Mr. Moore, who till then had functioned in the capacity of Advisory Officer, proceeded on leave during October.

Latex Constituents

With the arrival of Dr. Roberts it became possible to recommence the important work on non-caoutchouc constituents of latex, and considerable progress has already been made. It has been possible, by means of a new technique, to separate from latex a number of constituents which are different in properties from any which have previously been recorded in the literature. Some of the new substances have already been obtained in a crystalline condition and during the coming year, when stocks of them have been accumulated, it will become possible to characterise them. It is very probable that these constituents, of which some are often present in appreciable amounts, play a direct part in the observed variability in plantation rubber and latex. There are also indications that the work may throw light on the elusive problem of the physiology of latex production. The new separation-technique evolved by Dr. Roberts has demonstrated considerable day-to-day variation in the amounts of some of these constituents and it will in all probability prove to be a most valuable and at the same time ready means of detecting clonal, as well as day-to-day and seasonal differences. It is also applicable to the investigation of the progressive changes which take place in latex when preserved with ammonia.

Latex Preservation

General

The industrial demand for preserved and concentrated latex has been well maintained during the year. It has been predicted

repeatedly that users were becoming more exacting in their requirements in respect of uniformity, colour and stability and there are now unmistakeable signs of the preference of buyers for supplies which are known to be drawn from large bulks whether of concentrated or normal field latex. Large-scale bulking provides the readiest means of smoothing out day-to-day variations in essential properties and it has been noticeable that a number of estates which have in the past shipped latex, but which for want of bulking equipment were compelled to make up consignments piecemeal, have ceased to ship latex. The indications are that estates which are unable to instal large-scale bulking equipment, or alternatively to achieve the same results by group arrangements for shipment in steamer tanks, will find the latex market increasingly difficult.

Colour of Preserved Latex and Treatment of Shipment Vessels

Reference was made in the last report to an investigation into the cause of discolouration in preserved latex and to work which was in progress to find means of preventing discolouration by the development of protective coatings for iron shipment vessels. In a recent publication a description is given of the latex-zinc oxide-filming medium which in large-scale trials with preserved field latex has been found very effective against discolouration. This drum-filming medium, while ensuring a good white colour in the latex, has however the disadvantage that it tends to reduce its stability. Some buyers attach considerable importance to high natural stability and producers have been asked, before employing this zinc oxide filming medium, to make sure that the buyer is not one of those to whom high stability is essential.

It is gratifying to note that a firm in Singapore now markets latex drums which have been treated internally before assembly with a proprietary bituminous product which was tested at the Institute and found effective against discolouration. The product is not one which can be applied to the interior of ready-assembled drums because it dries too slowly; it must be applied and dried by the maker before assembly.

In view of these developments it should now be possible for producers to avoid complaints against discolouration.

Putrefactive Odour in preserved Latex

It has not been possible so far to develop a simple test for putrefactive odour in preserved latex, but there is additional evidence of the correctness of the opinion which was expressed in the last report, that producers would do well to regard 0.70-0.75 per cent ammonia as the minimum amount for safe preservation

especially if there is any danger of the preserved latex being stored for some weeks after arrival at destination.

It should also be noted that, although the common latex bacteria are usually destroyed by ammonia, there are some indications that they may be capable of developing strains which have greater resistance to it. Such resistant strains might develop in latex factories in utensils and on floors and latex producers would be well advised to disinfect periodically all utensils, floors and drains with a powerful disinfectant of the tar-acid type. The establishment in any latex factory of bacterial strains strongly resistant to ammonia might result in infection of the product and have very serious consequences.

Stability of preserved Latex

The question of stability of preserved latex has assumed more importance during the year, but there is a surprising lack of unanimity among users as to the best method for measuring this property. It is a matter of extreme difficulty to devise a test from the results of which it will be possible to predict the behaviour of a particular consignment of latex during the processing and manufacturing stages of a particular latex article. It is fairly safe to say that no stability test is yet available which fulfils all requirements. Towards the end of the year two different pieces of apparatus were obtained at the Institute for stability tests and these will be employed in the coming year to explore stability variations and to discover if possible the causes of the variations.

Physical Properties of Latex

During the year, viscosity and surface tension measurements have been made on a fairly wide range of latex samples. The range needs further extension before a reliable viscosity-dry rubber content table can be produced for preserved latex. There are strong indications, based on observations on more than three hundred different latex samples, that there is no real correlation between surface tension and dry rubber content of latex. The possibility of the existence of a correlation between the surface tension and the acetone extract and acid value of the whole rubber from latex, has been partially explored.

Alternative Methods of Preservation

(i) *Caustic Alkalis and Formalin*

As in past years small consignments of latex preserved with caustic potash, have been exported. There have also been a few

enquiries for formalin preserved latex. The demand for these products is very limited and is not likely to expand.

(ii) *Proprietary Latex Disinfectants*

By the courtesy of the Dupont Co., U.S.A., it became possible to test the effectiveness of three new latex disinfectants which were styled by the makers "L.E. 5", "F.D. 6" and "F.D. 7" respectively. The following table summarises their behaviour when applied to normal field latex and to fresh latex containing 0.1 per cent ammonia:—

Material	Amount applied by weight on latex per cent	Normal field latex	Latex containing 0.1 per cent NH_3
		Remarks	Remarks
L.E. 5	0.25	No preservation	Fluid after two months. Discoloured.
L.E. 5	0.5	No preservation	——
F.D. 6	0.1	No preservation	Fluid after two months. Discoloured.
F.D. 6	0.5	No preservation	——
F.D. 7	0.05	No preservation	Fluid after two months. Discoloured.
F.D. 7	0.5	Fluid after two months. Discoloured.	——

The two products "L.E. 5" and "F.D. 6" are unsatisfactory in fresh latex and, although they are more effective when assisted by a little ammonia, the discolouration which they induce in the latex is an undesirable feature. The product "F.D. 7", when applied in considerable amounts to fresh latex, will preserve it for a long period; it is also considerably more effective than "L.E. 5" and "F.D. 6" in presence of a little ammonia but it also produces an undesirable discolouration.

A disinfectant name "Metro" which is of the tar-acid type proved to be quite unsatisfactory even in presence of approximately 0.1 per cent ammonia. This behaviour was not unexpected because no disinfectant of this type has ever shown promise in our hands.

By the courtesy of the Wallace and Tiernan Corporation of New Jersey, U.S.A., we were able to test the recently developed and powerful disinfectant azochloramide. This substance is only slightly soluble in water. It was found to be ineffective in preserving either fresh latex or latex containing 0.1 per cent ammonia.

(iii) *Non-proprietary Mercury Compounds*

It was indicated in the last report that some mercury compounds, when applied to latex containing a little ammonia, maintained the latex in a fluid condition. During the year a fairly wide range of mercury compounds has been examined from the view point of preservation. The range includes:—mercuric cyanide; ethyl mercury chloride; o.chlor mercury phenol; mercurophen; mercury succinimide; mercury thiocyanate; mercury tannate (ous); mercury arsenite; mercury benzoate; mercury salicylate.

Of these substances, mercuric cyanide was the most suitable. When added to fresh latex in the proportion of 0.1 per cent by weight on the latex, coagulation is prevented; the latex remains fluid for several days, after which a slow thickening to a buttery mass ensues. Coagulation does not however take place and the addition of 0.1 per cent ammonia produces an almost instantaneous change from a thick buttery mass to a free-flowing latex. None of the other mercury compounds are equally effective in fresh latex. When latex is preserved initially with 0.1 per cent mercuric cyanide plus 0.1 per cent ammonia, no thickening takes place even over periods of several months.

It has been found that, although some of the mercury compounds, when added to latex containing 0.1 per cent ammonia in amounts of the order of 0.05—0.075 per cent, will maintain it in a fluid condition for over two months, if long period preservation is to be ensured, the minimum safe amount, even of the best mercury compounds, is 0.1 per cent by weight on the latex.

All the mercury compounds tend to a greater or less extent to induce discolouration in the latex, and of them mercuric cyanide is the least objectionable in this respect.

The succinmide, thiocyanate, tannate and arsenite were found to be quite unsatisfactory as preservatives of latex containing 0.1 per cent ammonia. Of the remaining compounds, the cyanide, benzoate and salicylate are the most effective as preservatives, but the benzoate and salicylate induce more discolouration than does the cyanide. Mercuric cyanide was judged to be the most satisfactory of the mercury compounds tested.

A small consignment of latex preserved with 0.1. per cent mercuric cyanide plus 0.1 per cent ammonia was shipped to the

laboratories of the London Advisory Committee. It arrived in good fluid condition though somewhat discoloured. On further examination by our London colleagues it was found to be exceptionally stable as judged by the stirring stability test in presence of zinc oxide.

Mercuric cyanide is a highly poisonous substance and, on this account, producers are warned that, unless a buyer should ask specifically for latex preserved with it, it should not in any circumstances be used as a preservative. It is felt however that latex preserved with this substance may perhaps prove to be of interest to certain buyers who desire very high stability and whose products are not such as are used in circumstances which are likely to result in poisoning.

(iv) *Sodium arsenite*

This substance, which like mercury cyanide is toxic to humans, was found, in laboratory trials with latex containing 0.1 per cent ammonia, to preserve latex in a good fluid condition for several weeks when applied in an amount equal to 0.15 per cent by weight on the latex. Shipment trials with latex so preserved have however indicated that the latex developed a rather unpleasant odour in transit. The indications therefore are that for safe preservation larger amounts of sodium arsenite are necessary.

(v) *Hexyl resorcinol*

This substance was tested as a possible preservative but was found unsatisfactory both in fresh latex and also in latex containing some ammonia.

(vi) *"Acid" Latex*

Towards the end of the year attempts have been made to produce an acid-preserved latex direct from the fresh material. The experiments made to date are promising but it is not possible to predict at present whether the future for acid latex is a real one.

(vii) *General*

So far no really satisfactory non-alkaline disinfectant-preservative has been found for latex.

Latex Concentration

(a) Concentration by Creaming

(i) *Storage before creaming*

It has been repeatedly observed that the results obtained with almost any creaming agent are better when it is applied to latex

which has been preserved for some time, than when the latex is freshly treated with ammonia. Experiments conducted with Tragon A gum as the creaming agent on samples of the same latex preserved for different periods before being taken for test, indicate that, if a storage period of a week is allowed before creaming, appreciably better results may be expected. After a storage period of approximately six weeks, the dry rubber content obtainable in a creaming period of 48 hours reaches its maximum.

(ii) *Creaming after rapid freezing and thawing of Latex*

No improvement in creaming appears to result from a pre-treatment involving freezing and thawing.

(iii) *Chemical pre-treatment of Latex before creaming*

It has been sought to improve the ease of creaming by means of various chemical treatments prior to the creaming process proper. Varying degrees of success have attended these efforts and experiments in certain directions will be continued during the coming year. Precise details of the experiments cannot be given at present.

(iv) *Tests on new creaming Agents developed in the Laboratories of the London Advisory Committee*

In the course of their own researches on the mechanism of the creaming process, a large number of materials have been found by our London colleagues to give promising results when applied to ammoniated latex in England. Samples of these materials have been passed to us for tests on freshly ammoniated latex. Of the materials so far tested, a number have given promising results in our hands, but none are actually more efficient than the Tragon A gum which is now used at the Institute as a standard of comparison.

(v) *Patents*

Details have recently been published of British Patent No. 415,133 which describes an improved method of creaming with gum tragacanth and alcohol, and of British Patent No. 430,935 which deals with the use of Tragon A (Carob seed) gum as a creaming agent.

(b) Centrifugal Concentration of Latex

In the second half of the year it became possible to carry out experiments with the Vickcen centrifuge installed at the Institute. It was predicted in the last report that the performance of the

machine in Malaya would not be so good as that obtained under test in England. Such has proved to be the case.

It was found possible to produce concentrates containing 60 per cent dry rubber; corresponding skim fractions are lower in dry rubber content than those previously obtained with another type of centrifuge but not so low as had been hoped. It is estimated that machines of this design would require to be stopped for cleaning after approximately one hour's running under estate conditions. It is felt that further improvement in design will be necessary if maximum efficiency is to be achieved.

Small but definite improvements in separation efficiency have been obtained by certain pre-treatments of the latex prior to centrifuging. This phase of the work is incomplete and details cannot yet be presented.

(c) Concentration by Evaporation

Apparatus for this work did not become available during the year, but it is expected that a small experimental plant designed in the laboratories of the London Advisory Committee will be installed and operated during the coming year.

Clone Rubber and Latex

Clone Latex

It has not been possible to continue the work on variation in clonal latex described in the report for 1934. It is expected however that towards the end of the coming year the problem will be attacked from a new angle by the technique which Dr. Roberts has developed for the separation of latex constituents.

Clone Rubber

The examination of rubber from the Pilmoor clones has continued throughout the year. It had previously been recorded that the rubber from two of the four clones tested appeared always to be slightly faster in cure than that from the other two clones. This difference has persisted in all the samples tested throughout the current year and there is little doubt but that the difference is a real if only a small one. It implies that natural differences in rate of cure may be expected among clones which have been used extensively in commercial planting. It does not however imply that such differences as may later be found in the rubbers from commercially planted clones will be such as need cause any alarm among producers or manufacturers.

The seasonal variations to which all the Pilmoor clones responded similarly, as indicated for instance by low tensile moduli

or slower cure after wintering, have again been observed in the rubbers tested during 1935.

It is now felt that the tests on the rubber from the Pilmoor clones have provided a very necessary background of experience in relation to the nature and extent of the seasonal and inherent variations which are likely to be shewn by commercially-planted clones. In January 1936, a block containing a number of clones which have been used extensively on estates will be brought into tapping on the Institute Experiment Station and regular vulcanisation tests will be made upon the rubbers obtained. This work will supersede the testing of rubber from the Pilmoor clones.

Throughout the year the Schopper testing machine has been in commission. A plastimeter and an ageing oven similar to those employed in the laboratories of the London Advisory Committee have also been obtained and are now in regular use together with the Biere-Davis oxygen bomb. The tests which are to be carried out on the rubber from commercial clones will include the property of plasticity as well as those of rate of cure and ageing.

Coagulants

Sulphuric Acid

A few estates have continued to use this coagulant during the year. There are however welcome signs that the number is decreasing and that the advice which has been given against its use has not been without effect.

Coagulants used by Malayan Small-holders

The Asiatic Rubber Instructors of the Small-Holders' Rubber Advisory Service in the various districts have enabled us to broaden the survey of the coagulants used by small-holders by obtaining further authentic samples. The use of coagulants other than formic or acetic acid is as a matter of policy being discouraged, but it will be some time before the use of these two acids becomes general. The small-holder himself is in nearly all cases in the hands of the small dealer who sells the coagulant in bottles; the user, even if he can read, has no means of discovering whether a bottle labelled "acetic acid" does in fact contain it. Our tests have shown that all too frequently, the bottle does not contain that which its label indicates; in many cases samples which purport to consist of acetic or formic acid consist in the main of sulphuric acid. Representations to the dealers responsible will no doubt have its effect in time.

Special Coagulant Mixtures for alkaline Latex

Reference was made in the report for 1934 to the development of coagulant mixtures containing sodium silico-fluoride together with magnesium sulphate or magnesium chloride, for the coagulation of alkaline latices. It was felt that these would assist producers who had on hand stocks of old unsaleable ammoniated latex, of the skim from centrifugal concentration of latex, both of which present very serious manufacturing difficulties. It is pleasing to record that during the year the development of these mixtures has justified itself. The advice of the Institute has been sought by estates wishing to transform unsaleable ammoniated latex into saleable rubber and in each case the advice has been brought to a successful issue. In one case the product was made and sold in the form of sheet rubber and incurred only a very slight penalty; this in spite of the fact that the original latex was in an unsaleable condition.

The Preparation of standard and modified Rubber

Copper Contamination of ammoniated and normal field Latex

Serious consideration has been given during the year to the matter of copper contamination of latex. It is by no means unusual for the producer to pass ammoniated latex through the brass sieve which is normally used for fresh latex, and because of the obvious danger of contamination, an investigation of the effect of latex on sieves of various types has been made. It has been found in the first place that latices which have never been in contact with a copper containing metal, have a small but distinct natural copper content, which requires but little artificial augmentation to show a distinct effect on the ageing properties of the rubber derived from it. It might be argued that, in normal estate practice, the fresh neutral latex is not in contact with brass for a period sufficiently long to acquire an appreciably increased copper content, but in view of the fact that clotted rubber which has been on the surface of a sieve for several minutes is often rubbed through into the bulk of latex, and in view of the further fact that safer sieving materials are available, there would appear to be no reason why a potentially dangerous sieving material should continue to be employed. Where ammoniated latex is concerned brass sieves are particularly dangerous. Estates have been advised to employ Monel or nickel gauze sieves. These are admittedly more expensive but the additional cost is offset by the fact of greater durability. Experimental details of this work will be published shortly and will include interesting vulcanisation and ageing re-

sults on rubbers prepared from latices to which homeopathic doses of copper have been deliberately added.

Rubber having the Property of low Water-Absorption

The search for methods of producing rubbers of which the water-absorption properties would be low enough to interest consumers in the electrical industries has continued during the year. Experiments have mainly centred round the enzymic decomposition of the nitrogenous constituents of latex by means of the enzyme papain. Rubbers both in the form of sheet and crepe have been prepared from latices stored in presence of papain for various periods before coagulation. Various soaking and washing treatments have been applied to the coagulum before and during machining. Nitrogen estimations have been performed on the finished rubbers and these have provided proof of very appreciable decomposition of the nitrogenous bodies present in the latex. No rubbers have yet been obtained which could be said to be nitrogen-free. It is freely assumed that rubbers having low nitrogen content will also show low water-absorption. Numerous tests made during the year indicate that this is in general the case but several exceptions have been found. In the second half of the year, rubbers which in our hands gave low-water-absorption were forwarded to the laboratories of the London Advisory Committee for check tests. Confirmation of the Malayan results were obtained and the stage has now been reached where a larger consignment will be prepared for electrical examination by an interested cable manufacturing concern.

Soft Rubber

A systematic examination is being made of the effects on the plasticity of air-dried and smoked sheet produced by deliberate variation in the amount of coagulant, variation in the degree of dilution of latex, and variation in degree of soaking of the coagulum before machining. This work is not yet completed. It may not point the way to the manufacture of an extremely soft rubber but it will probably indicate means of avoiding the production of an unnecessarily tough raw material.

In the course of the experiments on rubber of low water-absorption, several products have been obtained which are unusually soft as indicated by tests on the Williams plastimeter. Some rubbers, of which the nitrogen content is very low, have been found to be extremely sensitive to light; when exposed to light they become very sticky, then become soft enough to flow, and finally resinify. The phenomenon does not occur if the rubber is wrapped, or stored in a dark place. It is felt that these

observations provide an interesting field for further experiments on soft rubbers.

Conditions of drying and smoking and their Effects on the ageing Properties of Rubber

A systematic examination was commenced during the year on the ageing properties of rubbers dried at different temperatures in hot air and smoked to different intensities of colour. The factors of time of drying, temperature of drying and intensity of smoking are difficult to disentangle and the work is not yet completed. A preliminary paper has been published giving instances in which sheets dried purely in hot air and compared with sheets otherwise identical but dried in smokehouses, show inferior ageing properties in simple rubber-sulphur mixes. The work will be extended during the coming year and the time and temperature factors will be fully explored. The experiments will, at the request of the Socfin Co., include trials in "Socfin Dryers". It should be emphasised that the results so far obtained at the Institute are not such as need cause concern to users of these rapid drying installations unless drying temperatures in excess of 140° F are permitted.

Factory Equipment for the Manufacture of Sheet Rubber

Sheeting and sheeting Batteries

The line-ahead sheeting battery has now become the standard installation for the manufacture of sheet rubber. A few large estates machine the sheet as a continuous ribbon but this procedure does not commend itself to the majority of estates, partly because, if tearing is to be eliminated, coagulation should be carried out in tanks specially designed to ensure uniformity in coagulum thickness. Satisfactory tanks are obtainable but they are rather expensive and most producers whose crop can be machined with a modern battery in less than two hours, prefer to handle single sheets from the normal tank.

The "flooding system" for the conveyance of the coagulum from tanks to machines is becoming increasingly common. This system was originally proposed by Mr. Schweizer of Diethelm & Co., Singapore, and because of the simplicity of the operations of flooding the tank system and floating the coagulum to the machines without lifting and its attendant distortion, it has been freely recommended by the Institute.

Drying and Smoking

"Subur" type smoke houses have been erected during the year on a number of estates. The advantages of a single-storey house into which the wet sheet can be introduced on trolleys are self-evident. In respect of these houses some misconception appears to have arisen; in some circles it is stated that the product is either hot air-dried or semi-air-dried sheet. Such is not the case because throughout the whole of the drying period the rubber is subjected to an atmosphere of smoke. The product never assumes that shade of colour which would tempt a broker to classify it as "oversmoked sheet" but it need not nevertheless be so light in colour that it would be mistaken for hot air-dried sheet. When correctly operated, the rubber is first introduced into the cool chamber most remote from the furnace and thereafter at intervals of twenty four hours the trolleys are transferred to the next chamber nearer to the furnace; on the fourth day, drying is completed in the hottest chamber next to the furnace, at a temperature of 140°F. Complaints of blistering have been traced to the faulty practice of introducing very wet sheet direct into one of the hotter chambers.

It has been possible in the last four months to carry out tests in collaboration with the Asiatic Petroleum Co., on an oil-fired dryer erected at the R.R.I. Experiment Station. In this equipment, hot air and gases generated in an oil-fired furnace are circulated rapidly through the rubber by power-driven fans, and suitable ports are provided for the intake and exhaust of air. With this equipment it has been found possible to dry rubber of thickness slightly in excess of $\frac{1}{8}$th inch in 48 hours. This has so far not been accomplished, however, without raising the temperature to over 140° F in the later stages of drying. The resulting hot air-dried rubber has, in common with hot air-dried rubber from other sources, shown rather poor ageing properties. It has not so far been possible to operate the installation at a cost as low as that usually returned by users of normal smoke houses, but it may later prove possible to improve the performance. In future trials, smoke will be introduced into the building during the whole drying process, and it is expected that this will improve the properties of the rubber. Drying trials with this installation will be continued in the coming year. The dryer lends itself well to investigations on the fundamental factors involved in the drying of rubber, because temperature can be closely controlled, the forced circulation of air ensures uniformity of temperature throughout the building and ventilation is similarly capable of close adjustment. Apparatus has been designed for the automatic recording of time and loss in weight of wet rubber sheets. This apparatus has been tested in

the laboratories and it is expected that in the course of the next year its use will have made clear the mechanism of drying as applied to rubber and it will be possible accurately to assess the economic advantages of elaborately designed dryers over the simply designed smoke houses of the day.

Service Trials of Rubber Flooring

The experiment in which samples of rubber flooring were supplied for test on the F.M.S. Railways by the Rubber Growers' Association, has now been in progress for over two years. The samples laid on the rake of coaches comprising the day mail train from Kuala Lumpur to Penang have been inspected at intervals during the year. At the last inspection late in the year, some deterioration was apparent in the samples supplied by all but two of the manufacturers. It should be possible in the course of another year to judge with fair accuracy which of the materials is best suited to tropical conditions.

Advisory Work and routine Chemical Examinations

The volume of advisory work has been by no means small. Enquiries have received prompt attention. The pamphlet on factory equipment and lay-out has been in great demand and continues to be well received.

Late in the year there arose an unusual advisory case in which an estate's factory water rapidly induced clotting when used for diluting latex. Investigations showed that the water was actually alkaline in reaction and rich in calcium due to the presence of dissolved carbon dioxide. The calcium was the causative agent of the premature clotting. It was removed and the water rendered satisfactory by the application of sodium aluminate. It is possible that there may be other isolated cases of this trouble and the case is described for the information of producers who may be experiencing it.

General

During the first half of the year, the Senior Officer was privileged to pay numerous visits to the laboratorties of the London Advisory Committee and to confer with the Secretary, the Superintendent of Rubber Investigations and other officers on research matters and testing technique. Meetings and visits were arranged often at inconvenience to themselves and the unsparing efforts which were made to assist us are gratefully acknowledged.

The presence of the Senior Officer was also requested at the Spring Meeting of the Rubber Division of the American Chemical Society in New York during the month of April. At this meeting a paper was given by Mr. George Sackett on manufacturers' crude rubber requirements and the Senior Officer gave by request a statement in response, indicating the extent to which the producer could be expected to meet these requirements. As a result of this meeting a Crude Rubber and Latex Sub-Committee of the Rubber Division was brought into existence and through it, the industry and the Institute will in future be able to obtain an authentic and reliable expression of American opinion on any matter relating to rubber. Conversely, the Committee provides a channel through which American consumers can convey to us and to the planting community their feelings on any matter which may assume importance to them in the future. A tour of visits to rubber factories and to factories producing latex articles was made. A detailed report was prepared and the gist of it was conveyed to the planting community in a lecture given in Malacca at the Annual Conference of the Incorporated Society of Planters. The American tour was marked by the most kindly consideration and help freely given by all of the many executives with whom contact was made.

Lectures

The following lectures were given during the year:—

Lecturer	*Venue*	*Subject*
A. Moore	Central Pahang Planters Association	Some Improvements in Smoked Sheet Manufacture
E. Rhodes	Incorporated Society of Planters Annual Conference, Malacca.	Raw Rubber and Latex in America

Publications

1. "Note on the Deterioration of Raw Rubber by Manganese" by J. D. Hastings and Edgar Rhodes

   R.R.I. Journal Vol. 6, No. 1

2. "Creaming Latex with Gum Tragacanth" by Edgar Rhodes and K. C. Sekar

   R.R.I. Journal Vol. 6, No. 2

3. "Creaming Latex with Tragon Seed Gum"
by Edgar Rhodes and K. C. Sekar

R.R.I. Journal Vol. 6, No. 2

4. "The Specific Gravity of Preserved Latex"
by Edgar Rhodes

R.R.I. Journal Vol. 6, No. 2

5. "Note on Toughness of Sole Crepe
by Edgar Rhodes

R.R.I. Journal Vol. 6, No. 2

6. "Internal Protective Coatings for Latex Containers"
by Edgar Rhodes and K. C. Sekar

R.R.I. Journal Vol. 6, No. 2

7. "The Effect of the Conditions of Drying on the Ageing Properties of Sheet Rubber—Part I"
by J. D. Hastings

R.R.I. Journal Vol. 6, No. 2

Malayan Agri-Horticultural Show

It was not possible to stage an elaborate exhibit this year. The competition for small-holders' rubber was given great prominence. A type of smoke house suited to the needs and the purse of the small-holder was exhibited and not only did it attract attention but there are indications that quite a number of small-holders who for want of money and guidance previously produced air-dried sheet are now interested in smoking their product.

Edgar Rhodes,

Senior Officer, Chemical Division

Kuala Lumpur,

3rd February, 1936

ANNUAL REPORT

EXPERIMENT STATION

Acreage Statement

Planted	...	975.75	acres	In Bearing 169.75 acres; Immature 506.00 ,,
Building Sites, Roads, etc.	...	67.00	,,	
Elephant Belt	...	83.00	,,	
Reserve Area	...	206.45	,,	
Total	...	1,332.20	,,	

N.B. Not included in above total area are 10 acres of *Hevea Spruceana* seed nurseries in the Jungle Reserve, leased from the Dept. of Forestry, for which no permanent grant is issued.

Distribution of Land

Botanical Division	...	659.75	acres
Pathological Division	...	28.00	,,
Soils Division	...	288.00	,,
Building Sites, etc.	...	67.00	,,
Elephant Belt	...	83.00	,,
Reserve Jungle	...	206.45	,,
Total	...	1,332.20	,,

Clearing

Felling, Burning & Clearing

Block 30 & 31: For the 1935 programme of work, it was decided to open up a further 80 acres of jungle reserve. This area, adjoining Block 28 on the south western boundary south of the road to Batu Tiga, was rentised. The area is to be divided into two plots to be called (a) Block 30 (40 acres), (b) Block 31 (40 acres).

Block 30 is reserved for the Botanical Division, and is to be felled, contour-lined, terraced and planted with ungerminated seed to be budded at a later date. No burning is to be done on this Block.

Block 31: This field is reserved for the Soils Division as a manurial trial plot on buddings. It is to be felled, lightly scorched, counter-lined, terraced, and planted with ungerminated seed.

Block 30: Owing to instructions that no burning was to be done it was decided to contourline in the jungle, before felling was carried out. Chinese labourers followed the lining labourers and cleaned the lining rentises up to 6 ft. width. A third gang followed and felled the standing jungle between the clean contour rows. Terracing was done by Tamil labour.

Block 31: Normal felling was done and the clearing was scorched 14 to 15 days after felling was completed. The rest of the work was similar to that carried out on Block 30.

The cost of all work to planting in Block 30 was $50.00 per acre, and for Block 31 was $34.00 per acre.

Block 5A: It was decided to open up a portion of the elephant belt on the eastern side of Block 5 adjoining Blocks 25 and 4. This area comprises seven year old rejuvenated-belukar (secondary jungle). Rentises were cut through the belukar at 20 ft. intervals, and after these had been cleaned up, the intervening belukar was felled between the rows. No burning or terracing was done.

Lining, Holing & Planting

Block 30: Lining was done 22 ft. x 11 ft. along contours. Due to the terraces being cut in the shape of a wedge, holing was done 2½ ft. x 2 ft. x 18 ins. Planting was carried out with four ungerminated seeds per point.

Block 31: Lining and holing was carried out as for Block 30. Planting was carried out with one pencil stump per hole.

Block 5A: Lining 20 ft. x 15 ft. Holing 2½ ft. x 2½ ft. x 2½ ft. Planting was done with one basket plant per hole, normal estate seed being used.

Nurseries

The large multiplication nursery in Block 1, mentioned in the report for 1934, was enlarged and now covers 6 acres. Normal estate seed has been planted in beds, and this will be budded early in 1936. Special beds are reserved for pod-picked clonal seed which, as it becomes available, is being planted out.

It has been decided to dispense with the suggested Natural Cover Demonstration Nursery, which was to be established on the Building Site, as it is considered that sufficient jungle species are present in Blocks 27, 28, 29, 30 and 31, where visitors can be taken.

The old nursery area in Block 12 has been planted with bush covers, and is to be lined and planted as an experimental plot, when the special planting material is available in 1936.

Block 4 nursery is being slowly eradicated and will be completely finished in 1936. This area will be planted as an experimental area.

Manurial Treatments

Nurseries in Blocks 1 & 4 received an application of Sterameal applied at the rate of 2 ozs per square yard.

Block 6: This block received its annual application of farmyard and artificial fertilizers in the respective plots. Girth measurements were taken for the Soils Division.

Block 18: The annual treatment of 1 pound of Sterameal per plant was applied, resulting in further improvement in growth and foliage.

Block 31: This new block was divided into 36 plots for experimental work to be carried out in 1936. Owing to the contour of the land, a single strand wire fence was constructed round each plot for easy identification of boundaries.

Soil profiles were obtained and data recorded by the Soils Division in bad areas in Blocks 17 and 21, where "hard pan" had been found. A manurial trial is to be laid down in 1936.

Catch Crops

Block 23: The final cropping of the tapioca plots was carried out, and pineapples and coffee are to be eradicated from the other plots in 1936.

A scheme of manurial trials with controls has been drawn up for this area. Losses amongst the rubber trees are recorded, caused by *Fomes Lignosus* and *Fomes Ganoderma*. The general appearance of the rubber trees in the "Tapioca" plots is very poor.

Roads, Bridges & Paths

All roads and paths have been upkept, and metalling and sanding were carried out when required.

Considerable upkeep of the Building Site roads was necessary as they were badly cut up by lorries transporting factory equipment.

In Blocks 27, 30 and 31, where single-strand plot fencing has been erected to separate the various treatments, paths are maintained which considerably assist supervision.

Cement bridges, made on the Station, have been laid down where necessary.

Drainage

Two rounds of normal upkeep drainage were carried out over the main system. The anti-malarial system of drains was upkept monthly.

In Blocks 30 and 31, it was found necessary to put in a system of drains, to carry the rain water to the jungle. Through the courtesy of the Forest Department we have been permitted to cut an outlet drain through their reserve to the Sungei Damansara which has considerably facilitated the drainage of these Blocks.

No new drainage was necessary on the remainder of the Station.

Terracing, Silt Pitting and Bunding

Terracing: 6 ft. wide wedge-shaped terraces were cut in Blocks 30 and 31. The cost of this work, done by Tamils, averaging 30 chains per acre, was $12.00 per acre. Little upkeep of terraces was needed in Blocks 27, 28, 29, as the rejuvenating forest growths and bushy covers helped to arrest serious erosion. In Block 24, due to the shade of the rubber trees, the low covers—*Centrosema pubescens*, *Pueraria javanica* and *Calapogonium mucunoides*—are dying back and slight upkeep of terraces has been necessary. The fern, *Nephrolepis biserrata*, is being established between terraces to avert erosion.

Cover Crops

Blocks 7 and 8: In these areas the cover crops, *Crotalaria anagyroides* and Lamtoro (*Leucaena glauca*) are dying off, due to the heavy shade. This is especially noticeable in Block 8 where all the timber and stumps have been removed. This rubber is now 7 years old, and the cover crop rows have been slashed to 3 ft. every six months. A noticeable feature of this experiment has been the fact that very few trees in the bush cover areas have been attacked by root disease, whereas in the clean-weeded strips, adjacent to the covers, losses by root disease have been heavy.

Block 13A and B: In this area of 5 acres, which was previously used as a cover crop demonstration plot, all weeding, except a 4 ft. rentis along the rubber rows, has been stopped. Indigenous plants, mostly *Melastoma polyanthum*, are coming up well.

Blocks 18, 19 and 24: In the low-lying peaty areas of these blocks, the fern *Nephrolepis biserrata* has established itself. This fern is growing luxuriantly and was causing some retardation of growth of the rubber trees. Circles 8 ft. diameter were cleaned round the plants in these areas. It will probably be necessary in 1936 to extend these rings, or to strip-rentis through the fern along the rows.

Block 26: Excellent regeneration of natural covers has taken place; eradication of bad growths is done monthly and a light topping of any fast-growing plants is carried out.

Block 27: This block of 50 acres (50 chains x 10 chains) has been divided into five main plots, which plots are again subdivided into five strips, 2 chains x 10 chains. There are five treatments, replicated five times. The treatments are as follows:—

(1) Leguminous Shrub Covers	-	Lamtoro (*Leucaena glauca*) *Tephrosia candida* and *Crotalaria anagyroides* Slashed to 3 ft. every 6 months
(2) Leguminous Creeping „	-	*Centrosema pubescens*, *Pueraria Javanica* and *Calapogonium mucunoides*
(3) Natural Covers. System A	-	Minimum control of all plots; only light topping of fast-growing plants
(4) Natural Covers. System B	-	Slashing of covers to 3 ft. every 6 months
(5) Natural Covers. System C	-	All ferns removed, and belukar slashed to 3 ft. every 6 months

Terraces in all blocks to a width of 6 ft. are kept clean-weeded. *Melastoma, Gleichenia linearis,* lallang grass, stagmoss, Pteridium and Blechnum are removed in all plots.

An ecological study of regeneration and succession of plants, is being carried out by the Botanical Division on this area. The dominant plant to date is *Trima angustifolia.*

Selective eradication of large-stemmed plants has been carried out, all plants having a diameter of more than 4 inches at collar level, have been cut off below ground level.

Blocks 28 and 29: The belukar between terraces in these plots was slashed to 3 ft. and, in future, only light topping will be carried out.

Enquiries regarding cover crop seed, etc. have been numerous, and sales have been made of seed and cuttings.

Clitoria cajanifolia, which has been used on the Station during the past 6 years, for binding bunds, has come into favour lately and sales of seedling plants of this cover have been made.

Rubber under Natural Undergrowths (Block 11). Age 6—7 years

In this block, which was fully described in the Annual Report 1933, several interesting observations have to be recorded.

Tapping being due to commence on the 1st January, 6 ft. wide rentises were cut through both the slashed and unslashed covers and a census of tappable trees was taken. It was found that, in the whole 10 acres, only 400 trees conformed to the required standard, i.e. 20 inches girth at 22 inches from ground level. Most of these trees were located in the cleaned-up central strip. In the control plot Block 9 (clean weeded), a full stand was found available for tapping. It was therefore decided to start tapping Block 9 and to postpone tapping in Block 11 till July 1935.

In June 1935, a second census of trees was taken and it was found that there were then 950 tappable trees, a considerable increase on the previous figures, due probably to the cutting of the rentises arresting competition by the belukar plants. Tapping was started on the first July and the latex from each treatment was collected separately.

Considerable retardation of the rubber trees in the close-planted unslashed blocks is noted, whereas the retardation in the slashed areas is much less.

During the rainy months (October—December) Monthly Rot was noticed in the close-planted areas in this block (22 ft. x 11 ft.). Five trees only were affected in the unslashed and clean areas, whereas in the slashed area, where the fern *Nephrolepis biserrata* is growing luxuriantly, fifteen cases were recorded. On the advice of the Pathologist, it is proposed to widen the rentises in the slashed fern area. It should be noted that, owing to each tapper having to tap across all these treatments, rentises have had to be cut from east to west. The direction of the prevailing winds on the Station are from north to south, and if the rentises could have been cut in this direction, more rapid drying of the tapping panels might have occurred and the incidence of Mouldy Rot been decreased. No Mouldy Rot was noticed in any of the plots, where the planting distance was 22 ft. x 22 ft.

Termites are prevalent in the wide-planted areas in all plots and root disease is appearing again in the cleaned-up control strip.

Root disease in the unslashed and slashed areas is practically negligible.

Soil Wash Experiment with Bush and Low Covers

Block 19 (3.6 acres): Measurements of soil movement were made in each of the nine strips of covers. Due to density of the rubber tree shade, a considerable number of the cover crops are dying off. It is proposed to replant these strips with covers that may grow under shade.

Seed of *Desmodium ovalifolium* (Sengat clover) kindly supplied by Mr. T. H. Menzies has been planted on one of these strips and is growing well.

Cultivation Experiments

Alternate-monthly weeding and forking of the 8 ft. rings kept free of covers, round young rubber plants, has been continued, and these plants show a much healthier appearance.

Block 19 (9 acres). In this area, where there are three treatments, i.e. three clean weeded plots, three plots in which grasses and covers are dug in once every 6 months and are then allowed to regenerate, and three control plots of grass and cover, measurements are taken twice a year and results sent to the Soils Division. The clean-weeded plots show better growth than the other treatments.

Block 3 (9.25 acres). Since the heavy cover of Centrosema on this area was dug in, excellent growth of the rubber trees has been recorded.

Block 25 (8 acres, Bush Covers, Clean-weeding and Low Covers).

Growth in the clean-weeded and Lamtoro areas is excellent, but retardation is noticeable in the plots containing grasses and Centrosema. Girth measurements are taken twice a year for the Soils Division.

Pests and Diseases

Slight traces of *Oidium Hevea* were noticed, but the attack was not serious. A serious attack by Thrips occurred during the wintering season, and it was found necessary to sulphur-dust. The attack showed clearly that it was the late wintering trees, both seedlings and buildings, which were affected, especially such clones as B.D. 5, S.R. 9 and AVROS 50. This leaf-fall effect was pronounced in the clone trial plot, Block 5. In some cases the attack was so serious that affected trees were defoliated three times. Dusting was carried out as for *Oidium Heveae*.

Caterpillars (Achea). In the 'Natural Cover' plots, Blocks 27, 28 and 29, an attack by caterpillars of six weeks' duration has to be recorded during the wintering season. Spraying with a 0.5 per cent solution of lead arsenite was carried out but was not successful. These pests defoliated the belukar plants only in the forestry areas, but attacked the rubber plants, when crossing over leguminous bushy and creeping cover strips. During the first attack 35 acres were defoliated in four nights. Three attacks occurred and these came at fortnightly intervals and lasted for

a period of 6 weeks. No further attacks were recorded during the year. Regeneration of the belukar took place after the rainy season in March—April.

Root Diseases: Regular rounds of inspection and treatment were carried out in all blocks during the year, treatment being the same as that described in last year's Annual Report.

The following list records the cases affected and treated during the year:—

Disease		Trees treated	Trees removed	Total
Fomes lignosus	...	1697	217	1914
Fomes ganoderma	...	65	47	112
Fomes noxius	...	25	19	44
White Ants	...	2384	312	2696
		4171	595	4766

Pink Disease: A few cases of Pink Disease were recorded; these yielded to the recommended treatment of a mixture of Asphaltum and Kerosene and 20 per cent. Brunolinum solution.

Mouldy Rot: This disease was only recorded in Block 11 as mentioned above, and all trees recovered after treatment.

Lightning: Several trees have been struck by lightning on the hill at the southern end of the Station. An aerial has been erected and it is hoped this will stop the trouble.

Sulphur-dusting: The two dusting machines being now six years old and needing constant repairs, it was decided to purchase a new one.

On the recommendation of Mr. Beeley a Vermoral Duster was obtained and, so far, has proved very successful.

Liaison with the Research Officers of the I.C.I. (Malaya), Ltd. has been maintained and several forms of sulphur-dust have been tried out.

Jungle Plots A and B (10 acres)

Segregation plots in the jungle, one budded with alternate *Hevea Brasiliensis* and *Hevea spruceana* plants and one pure Spruceana.

Routine weeding and slashing of the belukar between rows has been carried out bi-monthly.

Termites have proved troublesome and it has been necessary to increase the rounds of inspection.

In December the belukar was removed from two acres so that seed collection early in 1936 will be facilitated.

Weeding

The programme of alternate-monthly weeding and forking round plants was carried out. Selective weeding was done in forestry areas.

In Block 27, separate cost cards are kept of (a) clean weeding on terraces, (b) weeding between terraces while belukar is regenerating, and (c) selective pruning and slashing. These should prove of interest to planters interested in natural covers.

Lallang Grass. Except in the swamp areas in Blocks 18, 19, 17 and 22, and on the New Clearing Blocks 26, 27, 28, 29, 30 and 31, where a special patrol operates each month, all lallang eradication is done by the weeders on their monthly rounds.

Slashing. The Building site (Block 1) and main drain edges are slashed monthly.

Budgrafting

After-care of new buddings was carried out on regular rounds and bamboo shields put in where necessary.

Budding with crepe rubber bandages was again carried out. This method, while quite successful in the nursery, has proved a failure where the plants are exposed to the sun, as the crepe rubber becomes tacky.

Budding demonstrations have been given at various Agricultural Shows and to Penghulus and others visiting the Station.

The Conductor in charge of budding operations and the Mandor have visited a number of estates to help identify clones.

The special experiment on snag treatment of large buddings (Block 20) has been continued and results will be published by the Botanical Division. Budded stumps and stumped buddings were used for supplies in Blocks 18, 20 and 21.

Normal budding was done in the following Blocks:—

Block 17 B	...	2 acres
„ 25	...	2½ „
„ 16 F	...	2 „
„ 1 A	...	3 „

Budwood was received from Carey Island Estate (Jugra and Carey Clone No. 25) and was established in Block 4 Nursery and in Block 17 B.

Considerable sales of budwood of various clones were made during the year.

Test-Tapping

In Block 17A (10 acres alternate buddings and seedlings and in Block 14E (5 acres; plants tested with Dr. Cramer's knife) test-tapping was carried out for 10 days. Individual tree recording was done and weights of rubber obtained supplied to the Botanical Division. In Block 17A the seedlings only were test-tapped.

Block 5: Clone Trial Block (40 acres)

Test-tapping of the boundary rows only was carried out from February onwards.

Three systems were employed :—

(1) Western boundary ½-spiral left, at 40 inches

(2) Eastern boundary ½-spiral left, at 20 inches

(3) Southern boundary two-½-spirals on opposite sides of the tree at 20 and 40 inches. Three months tapping and three months rest.

(4) Northern panel, rested and tapped when southern panel is rested. All tapping was alternate-daily.

Block 6: Manurial Trial Block (40 acres)

In this field the boundary rows have not been manured, as they have been left as guard rows.

Test-tapping on these guard rows started on the 1st August. The system is similar to that used in Block 5, but an experiment with a full spiral (left) has been added. Tapping is done alternate-daily and individual tree recording is carried out.

No other test-tapping was carried out during the year.

Tapping

The following blocks were brought into normal tapping on the alternate-daily system. Tapping was done on a left-hand half-spiral, seedlings being opened at 20 ins. from the ground and buddings at 40 ins. on a left-hand half-spiral.

The slope of the tapping cut for seedlings was 22° and for buddings 30°.

Block	*Acreage*	*Planting distance*	*Material*	*Details*
2	30 acs.	30 ft. x 30 ft.	Seedlings	Individual tree recording. 1st January 1935.
3	9.25 „	20 ft. x 20 ft.	Buddings	Buddings made from high-yielding hand-pollinated crosses in Block 4. 1st July, 1935.

Block	*Acreage*	*Planting distance*	*Material*	*Details*
4	10 acs.	30 ft. x 30 ft.	Seedlings	Hand-pollinated crosses and controls. 1st January.
6	40 „	22 ft. x 22 ft.	Seedlings	Manurial Trial Plot. 1st January. Half of each plot on left-half spiral, half on V cut.
7	10 „	22 ft. x 22 ft.	Seedlings	Low and creeping covers with clean-weeded control; 200 buddings made from Brown Bast trees from an Estate. Surface timber and stumps left. 1st January.
8	10 „	22 ft. x 22 ft.	Seedlings	Replica of Block 7, timber and stumps removed. 1st January.
9	8 „	22 ft. x 22 ft.	Seedlings	(4 acres: timber and stumps) (4 acres: clean weeded 1st January.
11	10 „	5 acs. 22 ft. x 11 ft. 5 „ 22 ft. x 22 ft.	Seedlings Seedlings	Rubber trees in natural covers. Half slashed and half unslashed. 1st July,
13	2. 5 „	„ 22 ft. x 22 ft.	Seedlings	Bark removal experiment. ¾ ins. A.D. 1/3 area 1 in. A.D. „ „ 1¼ in. A.D. „ „ 1st January.
16	40 „	20 ft. x 20 ft.	Seedlings	Hand pollinated crosses and controls. 1st April.

Note

All hand-pollinated crosses on the Station in tapping were made on Pilmoor Estate.

In the case of trees individually recorded, the daily samples are hung on wires on the trees and are collected monthly, sent to Pilmoor or Bujong Estate for crepeing, then dried and weighed at the Experiment Station.

In fields where collection of latex takes place, specially marked buckets are issued for each treatment.

Tapping in Block 6 and the boundary row experiment in Block 5 is carried out by Chinese; all other blocks are tapped by Tamils.

In each field, tapping tasks are rotated each month, to help eliminate the human factor. Bark consumption is at the rate of ¾ inch per month. Bark shavings are kept in special baskets on the trees and are collected, creped, and weighed monthly.

The crop harvested for the year was 35,215 lbs. from 169¾ acres.

No tapping was possible on 20 days, and tapping was interfered with on 93 days during the year.

Curing

The temporary factory, with hand-machines and pans, was used during the year.

The new factory buildings, crepe-drying shed, and packing shed were erected during the latter part of the year.

A special 6-roll sheeting battery was installed and a crepeing battery is on order, for treating the coagulum from individual trees.

It is hoped to start using the new buildings early in 1936.

The small Devon-type smoke house has proved very successful, pan sheet being dried in 3-4 days.

Two hessian (gunny sacking) smoke houses, one small and one large, suitable for small holders' use, were erected. Both proved successful and economical; four small models were made for use on His Highness the Sultan of Selangor's land at Bandar. A new type of air-drying Cabinet is on trial. Several trials were carried out by the Technical Officers of the Asiatic Petroleum Co. and the Institute. Air-dried sheet can be prepared in 48 hours, but there are several difficulties still to be overcome. Further tests are being conducted and will be reported on later.

We have to thank the General Manager, Kepong Rubber Estates Ltd., for his assistance in supplying large quantities of sheet rubber for these tests.

Measurements

Girth measurements were taken at regular periods on the following blocks: 5, 6, 7, 8, 9, 11, 14, 15, 16, 17A, 17D, 20, 21, 22, 24, 25, and records are sent to the Institute for analysis.

Medical and Health

Health continued to be good; there were no cases of fever, amongst the European or Asiatic staff. A few cases of fever ocurred amongst newly-recruited local labourers.

The following is a list of hospital admissions during the year :—

Fever	*Maternity*	*Wounds, etc.*	*Total*
4	8	12	24

Brush-oiling was continued with satisfactory results and costs are very low.

An observation ward for minor ailments was erected and has proved most useful.

Drs. Macaskill and Cameron continued as our Visiting Medical Officers and thanks are due to them for their advice.

Rainfall

The rainfall for the year was 92.96 inches.

Very dry conditions were experienced during September and the early part of October.

Buildings and Machinery

All buildings are in a good state of repair, but some small upkeep of the cement aprons at the Lines Cattle Shed will be necessary next year. Insurance Policies cover all the buildings fully.

Staff

Mr. T. N. Dickson joined the staff on the 1st July 1936, as Assistant Manager.

The staff attached to the Station during the year were:—

Manager
Assistant
1 Clerk
1 Dresser
1 Field Conductor
1 Tapping Conductor
3 Botanical Laboratory Assistants } R. R. I.
1 Pathological „ Assistant } Staff

Correspondence

Correspondence dealt with during the year was as follows:—

Details	
Replanting schemes (Estimates)	8
Cover Crops and Natural Covers	60
Terracing and planting	35

Spraying with arsenic and other chemicals ...	20
Manuring (labour charges and tasks)	15
Budgrafting (Technique)	30
Total ...	168

The Nilai-Labu Branch of the Incorporated Society of Planters visited the Station in September and the Manager gave a lecture to this Branch at the Nilai Club previous to the visit.

History File and Cost Cards

A History File of the Station and Cost Cards are available for the use of all visitors.

General

During the year 306 visitors have been taken round the Station.

Visits have been made by the following branches of the Incorporated Society of Planters:—Nilai-Labu, Rantau-Port Dickson and Kuala Lumpur.

The Asiatic Rubber Instructors of the Small Holders' Advisory Service visited daily for a two weeks' practical course, before being sent to their Districts.

Visits by Chinese and Japanese planters have been numerous, and it is pleasing to record that visits are now being received from Malay Penghulus.

Officers from Research Stations in Ceylon and Netherlands India have visited the Station.

Seed fell early this year, at the beginning of September. A nursery was established in Block 31 for planting up this field later, when manures had been laid down. Unfortunately a very dry spell was experienced during the whole of September and early October and, although this nursery was watered, growth was poor. Thinning out of this nursery had to be carried out. Later in December, on the return of the Senior Officer of the Soils Division from leave, it was decided to plant first and manure later. Available plants were put out in the clearing, but, due to unfavourable conditions and attacks by rats, losses were heavy.

A basket plant nursery was established to supply the clearing, and these will be put out when the weather is suitable.

Recording of yields is increasing and accounts for the extra staff employed.

During the year, all cup samples have had to be taken to Pilmoor or Bujong Estate for manufacture. Thanks are due to

the Manager of Pilmoor Estate, and the General Manager of Kepong Estates Ltd., for their assistance in this connection.

The work of the Staff, both European and Asiatic, on the Station, is noted with appreciation.

Close co-operation has been maintained with the Research Officers of the Institute and thanks are due to them for their advice during the year.

H. W. Foston

Manager

LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA)

ANNUAL REPORT

The Committee and Technical Sub-Committee held four meetings during the year.

Membership of the Committee

Mr. S. F. Ashby succeeded Dr. E. J. Butler on retirement of the latter as Director of the Imperial Mycological Institute on 30th September.

In August Lieut. Col. Sir David Prain found it necessary for reasons of health to ask to be relieved of his position as representative of the Ceylon Government. At the close of the year no information had been received as to the name of his successor.

Professor R. G. H. Clements was appointed an additional member of the Technical Sub-Committee.

The following members of the Boards of the Rubber Research Institute, Malaya and the Rubber Research Scheme, Ceylon and of the research staffs in Malaya attended meetings of the Committee during the year:—

Board, Ceylon Rubber Research Scheme

Dr. W. Youngman, Mr. B. M. Selwyn, Lieut. Col. T. Y. Wright

Board, Rubber Research Institute, Malaya

Mr. A. P. Cranna, Mr. J. C. Innes.

Staff, Rubber Research Institute, Malaya

Dr. E. Rhodes, Mr. C. E. T. Mann, Mr. R. P. N. Napper, Mr. C. G. Akhurst, Mr. J. H. P. Piddlesden, Dr. K. C. Roberts.

Dr. Roberts and Mr. Piddlesden worked for a short period in the London laboratories before taking up their appointments in the Chemical Division of the Rubber Research Institute.

Appointment of Staff in Ceylon and Malaya

At the request of the Director of the Rubber Research Institute steps were taken by the Committee to select candidates

for three vacancies for chemists and two for botanists on the staff of the Institute.

The advice of the Committee was sought by the Government of the Federated Malay States with regard to the appointment of a new Director of the Rubber Research Institute in place of Col. Eaton who expressed his intention of retiring from Malaya on the termination of his present period of appointment in February, 1936. The Committee suggested that the offer of Col. Eaton to remain in the post until June should be accepted in order to ensure that adequate time may be available for making satisfactory selections for filling the vacancy. The suggestion was approved and in accordance with the authority requested from the Government the post was advertised towards the close of the year.

At the request of the Ceylon Rubber Research Scheme, the Committee advertised the appointment for an assistant botanist on the staff of the Scheme and selected and submitted the names of the three most promising applicants.

Finance

The expenditure incurred in connection with the work of the Committee during the year amounted to £2,994.3.7. After allowing for reserve for plant and for liabilities outstanding, there was an unexpended balance at 31st December 1935 of £700 of the general funds and of £439 of the special grant of £1,000 per annum for rubber roadway investigations received from the Rubber Research Institute, Malaya. There were also at that date balances of £108.14.4. held on behalf of the Rubber Research Institute of Malaya and of £170.17.4. held on behalf of the Ceylon Rubber Research Scheme from the funds supplied by them to meet expenditure incurred on their behalf.

The Boards of the Rubber Research Scheme, Ceylon and the Rubber Research Institute, Malaya agreed to the proposal of the Committee that they should continue their existing contributions of £1,400 a year each to the expenses of the work in London during 1936, subject to any other arrangements which may be made by the International Rubber Regulation Committee for financing rubber research in this country during the year. The Ceylon Rubber Research Scheme indicated, however, that no future contribution would be made to a joint scheme of work in London except on a basis proportionate to the acreage of rubber in Ceylon.

Rubber Roadways Investigation

As stated in the report for 1934 the Board of the Rubber Research Institute adopted in principle the proposal of the Com-

mittee that staff should be appointed to carry out in the London laboratories a systematic study from the rubber standpoint of the preparation and properties of latex mixtures for roadways, pavements and floorings. During the year information was received that the Board had approved an annual grant of £1,000 for three years for this purpose. Two additional assistants were accordingly appointed:—

Mr. W. W. Wren, B.Sc., A.R.C.S. (Physical chemist) who had previously been working on highway surfacing problems under Professor R. G. H. Clements at the City and Guilds Institute and Mr. A. T. Faircloth who had for many years been in charge of cement testing at the Imperial Institute.

Work was only commenced in June and progress has been made in a study of the fundamental properties of latex cement mixtures towards devising a suitable mixture for road surfacing. The microscopical, chemical and mechanical tests all indicate that, contrary to expectations, cement does not always combine chemically to an appreciable extent with the water in latex.

The results so far obtained have been discussed personally with representatives of the Building Research Board and arrangements made for contact to be maintained with the Board throughout the investigation.

Co-operation with the Rubber Growers' Association Technical Research Committee

Full co-operation and liaison was maintained with the Rubber Growers' Association throughout the year and the Association's technical liaison officer paid several visits to the Committee's laboratories during the year.

The investigations on rubber crumb for which funds are provided by the Association's Technical Research Committee were principally concerned during the year with the incorporation of crumb with asphalt. After a number of private trials a small section was laid on the public highway by the Limmer and Trinidad Lake Asphalt Company last summer and very encouraging reports have been received as a result of the trial. This roadway has a very good sandpaper surface which may be due to the rubber preventing the flow of bitumen and polishing by traffic, and proposals for the laying of further trial sections during 1936 are at present under discussion with the Limmer and Trinidad Lake Asphalt Company.

Rubber crumb was tried by the Asphalt Company in several areas for use in white traffic lines. In view of their satisfactory behaviour a large number of additional orders has been received by the Company and the Ceylon Rubber Research Scheme was

asked to prepare a large consignment of crumb to meet their requirements.

Attention was also given to the incorporation of rubber crumb with other products. Some of these are promising but none has yet reached the commercial stage.

Co-operation with other Organisations

Mr. Martin continued to serve as a representative of the Research Association of British Rubber Manufacturers on the Joint Committee of that Association and the British Electrical Research Association dealing with the quality of ebonite. The investigations have now reached a stage at which experimental consignments are being prepared in the East for trials by manufacturers.

Mr. Martin also served as a representative of the Rubber Growers' Association on the Committee for Standardisation and Co-ordination of Tests for Rubber of the British Standards Institution. Among the subjects under consideration by the Committee is the testing of latex and of unvulcanised rubber. Suggestions have been put forward for the consideration of the British Standards Institution and in addition a detailed statement of the methods employed by the Committee is being prepared for publication.

As a result of the visit by Dr. E. Rhodes to the United States of America in 1935 the Rubber Division of the American Chemical Society appointed a Crude Rubber Committee to act as a clearing house for information on the quality requirements for crude rubber and latex. Co-operation between this Committee and the London Advisory Committee has been arranged and the principal reports issued in London are forwarded regularly to the Crude Rubber Committee for comments and criticism.

Patents

Abstracts of English patent specifications in respect of inventions relating to processes for the preparation and/or utilisation of raw rubber and latex were made for the information of the Rubber Growers' Association, the Rubber Research Scheme, Ceylon, and the Rubber Research Institute, Malaya, and attention was drawn to claims which appeared to lack novelty and to cases where the grant of a patent would be likely to be prejudicial to the interest of the rubber growing industry.

In conjunction with the Rubber Producers' Research Association steps were taken to obtain English patents in connection with inventions arising out of the work of the staff in London and the East.

Applications sealed during 1935

428,100—A process for obtaining homogeneous dispersions of unvulcanised rubber in tar which previously could not be obtained.

433,303—A process of concentrating latex whereby concentration is obtained without the use of protective colloids.

Complete applications accepted during 1935 and awaiting sealing

437,758—A process for creaming latex by the use of alkylated starch.

Complete applications filed during 1935

1275/35—A process for creaming latex by means of hemicelluloses extracted from a variety of vegetable materials.

4529/35—Modification of process of concentrating latex described in patent specification No. 433,303.

Provisional specification filed during 1935

13,032/35—Chlorination of nitrite crumb (in conjunction with work on modified rubbers being carried out at the Imperial College of Science for the Rubber Growers' Association.)

INVESTIGATIONS

No fresh schemes of work were initiated during the year, but steady progress was achieved in the various lines of investigation described in detail in the report and the technical appendix for the year.

Priority was again given to problems relating to the use of latex as distinct from raw rubber problems. Useful progress was recorded in (1) devising colour standards for latex, and (2) concentrating latex by evaporation. A wide variety of data were collected as to the value of hemicelluloses as creaming agents of latex.

Mr. H. C. Baker spent one term working at Birmingham University with Professor W. N. Haworth studying the preparation of new types of creaming agents for latex, previously discovered in the Committee's laboratories. A wide range of samples has been prepared and sent to the rubber research staffs in Ceylon and Malaya for practical trials.

Some areas of budded rubber are now being tapped and an increasing amount of time will have to be devoted to the examination of rubber from these clones. Preliminary investigations have shewn considerable difference in plasticity and ageing properties, both of which are of importance to the rubber manufacturer. Tests on a large number of samples from various

sources will, however, be necessary before any definite conclusions can be drawn as to the quality of clone rubber.

As in previous years, the staff in London co-operated with the chemists in the East in the examination of samples prepared in connection with experiments in Ceylon and Malaya. A list of the reports furnished on these investigations and on others initiated in the Committee's laboratories is given below. Further information as to the investigations completed and in progress during 1935 will be found in the technical appendix to this report.

P. J. Burgess

Chairman

Imperial Institute,

London, S.W. 7

May, 1936.

J. A. Nelson

Secretary

Reports on investigations forwarded to Ceylon and Malaya during 1935

Investigations connected with the Study of Methods of preparing a soft Rubber suitable for manufacturing Purposes

Softened rubber
Physical properties of rubber-bitumen mixtures.

Clone Rubber

Clone rubber.

Water-absorption Experiments

Effect of conditions of testing on the results of water-absorption tests.
Preparation of rubber with low water-absorption for electrical purposes.
Water-absorption experiments.

Experiments on the Preservation of Latex

Preservation of latex with mercuric cyanide.
Preservation of latex with chemicals other than ammonia.

Latex testing and Specification

Development of latex specification.

Creaming of Latex

Creaming agents.
Homogenised latex.
Experiments to determine the cause of variability in creaming of latex.

Latex Containers

Latex containers.

Nitrite Crumb

Properties of solutions of nitrite crumb in organic solvents.
Nitrite crumb.
Viscosity of nitrite rubber crumb solutions.
Nitrite crumb.

Comparative vulcanising and ageing Tests

Comparison of results of tests on clone rubber in Malaya and London.
Testing of rubber.
Comparison of results of tests in Rubber Research Institute, Malaya and London Advisory Committee laboratories.

Special Forms of Rubber

Rubber prepared from field latex by coagulation with magnesium chloride-sodium silicofluoride mixtures.
Rubber from centrifuged skim latex.
Patterned Para.

TECHNICAL APPENDIX

TO THE ANNUAL REPORT OF THE

LONDON ADVISORY COMMITTEE

Latex

SPECIFICATION AND TESTING

Reference was made in last year's report to a proposal for a conference to discuss the technological problems relating to quality involved in devising tests for inclusion in a trade specification for latex. A conference attended by representatives of producing, manufacturing and commercial interests was held at the Imperial Institute in July to discuss various methods of testing collected by the staff. The discussion indicated that no difficulty was likely to be experienced in standardising chemical tests for dry rubber content, total solids and alkalinity, but the conference concluded that much more work is necessary before physical tests for colour and stability can be standardised.

A useful suggestion with regard to the preparation of colour standards for liquid latex was received from a member of the Rubber Trade Association and has since been developed by the staffs of the Dunlop Rubber Co. and of the Committee.

A series of colour standards was prepared from mixtures of titanium dioxide, carbon black, cadmium sulphide with a sodium silicate binder for submission to the Rubber Growers' Association.

Little attention has yet been paid in the Committee's laboratories to the determination of the colour of dried latex films which is of considerable importance in connection with the manufacture of dipped goods and which, according to a member of the conference and to information supplied by the staff, cannot be correlated accurately with the colour of liquid latex. Useful suggestions were received from the staff of the Dunlop Rubber Company and it is hoped to devote more time to the subject during 1936.

The opinion was expressed at the Conference that a specification for the quality of latex should include a test for stability. Several tests were considered but absence of fundamental knowledge concerning the factors involved prevented the Conference arriving at a definite decision. In view of the further work required the problem was referred to a sub-committee to arrange details.

Particular attention has been given in the Committee's laboratories to a stability test which involves stirring in the pres-

ence of zinc oxide, and a study has been commenced of a number of factors likely to affect the accuracy of the results. Information has been obtained indicating that coagulation under the conditions of the test is due partly to the chemical action of zinc oxide and partly to the mechanical effect of stirring. It is desirable that these two factors should be studied separately, and investigations are in progress along these lines. One of the chief difficulties in drawing practical conclusions from the results of this test is that chemical and mechanical stability of latex are partly dependent upon alkalinity and dry rubber content and can be considerably increased by the addition of well-known protective colloids.

Microscopic observations in the Committee's laboratories indicate that most samples of latex show a slight aggregation of rubber globules on arrival in this country, possibly owing to delay in adding ammonia on the estate or to imperfect preservation. Although there is no doubt that the aggregates can be stabilised and prevented from increasing in size by the addition of protective colloids, their presence must affect the uniformity of mixtures of latex and compounding ingredients and is therefore of some technical importance. It has not yet been established experimentally that slight aggregations are irreversible, but large aggregations amounting to minute clots of coagulum in the latex cannot be dispersed and it is therefore concluded that a test for aggregation may be of more importance than one for chemical and mechanical stability which can be easily modified by the user to suit his own requirements. Experiments are in progress with a view to obtaining a reliable microscopic method of determining degree of aggregation. Such a method would be unsuitable probably for incorporation in a latex specification for the general use of the latex trade, and consideration is therefore being given to sieving tests which are unfortunately less sensitive than microscopical examination, but may nevertheless serve a useful purpose.

It is customary to add 0.5 per cent ammonia (expressed as NH_3) for the preservation of field latex. The Conference agreed that data provided by Dr. Rhodes indicated that the amount was inadequate for field latex containing 40 per cent and less dry rubber and recommended that the addition of 0.75 per cent should be standardised. This recommendation was forwarded to the Rubber Growers' Association.

Concentration

The experiments on the concentration of latex referred to in the last report have been continued.

(a) *Creaming*

An examination of the properties of gum tragacanth (in relation to the literature references as to its constitution) which is an efficient but somewhat unreliable creaming agent, led to a study of the effect on creaming of the alkylation of a number of complex carbohydrates. Of the compounds studied only alkylated starch and dextrine were found to be creaming agents.

During the study of the creaming properties of alkylated carbohydrates, creaming experiments were made with the caustic soda extracts of cereal straws. The extract was a good creaming agent and it was subsequently shown that the effect was not due to lignins which are alkylated carbohydrates but to the hemicellulose portion of the extract. As hemicelluloses are widely distributed in the vegetable kingdom the creaming properties of these materials from a large number of sources were tried. In nearly all cases they proved to be creaming agents, the most promising results being given by the materials extracted from linseed cake meal and brewers' grains.

In view of the complex nature of the carbohydrates under investigation arrangements were made for Mr. H. C. Baker, who had carried out the previous work on the subject, to work for a time at Birmingham University in the chemical laboratory directed by Professor W. N. Haworth, who is a recognised authority on the constitution of carbohydrates and on the methylation of starch.

Mr. Baker showed that starches containing between 7 and 24 per cent methoxyl were relatively efficient creaming agents.

A large number of methylated starch and hemicellulose creaming agents were prepared at Birmingham and in the London Advisory Committee laboratories and samples forwarded to Ceylon and Malaya for tests on the creaming properties of freshly-preserved latex in the East.

While at Birmingham Mr. Baker examined the creaming properties of a large number of carbohydrates and obtained positive results with two pure carbohydrates, namely lichenin, which is similar in constitution to cellulose but of smaller molecular size, and mannan which is a polymer of mannose anhydrite. He concluded that the capacity to cream latex was largely dependent on the physical nature of the creaming agent.

Towards the end of the year a study was commenced of the rate of creaming of latex in vessels of different dimensions and of the concentration gradient in the cream layer after various periods. The results so far obtained indicate that modifications in the design of the creaming tanks at present employed in the East should improve a little the rate of creaming and the degree of concentration obtained.

(b) *Evaporation*

A laboratory apparatus for concentrating latex to 70 per cent dry rubber content without the addition of protective colloids was devised during 1934 and further developed in 1935. The apparatus has proved its value as an aid to research and a similar apparatus capable of holding 10 gallons of latex was almost ready for despatch to the Rubber Research Institute at the end of the year.

(c) *Centrifuging*

A demonstration of a new type of centrifuge was attended by the staff towards the end of the year but it was evident that mechanical improvement was necessary before the machine would be suitable for continuous use in the East.

PRESERVATION

By general consent ammonia is the most satisfactory preservative of latex at present known, but it has some disadvantages, one being price and another its effect on the mucous membranes of the eye and nose, particularly when handled on a large scale under conditions where the vapour escapes freely into the atmosphere.

Samples preserved at the Rubber Research Institute with disinfectants arrived in London in a fluid condition, but were somewhat thick and pasty. The addition either in the East or in London of a quantity of ammonia (less than that required for preservation) reduced the viscosity of these latices to a value approaching that of ammonia-preserved latex.

The samples gave satisfactory results on tests and are regarded as promising, but the poisonous nature of the disinfectants used is a marked disadvantage. In addition the ultimate products display differences in behaviour from those from ammonia-preserved latex.

ROAD-SURFACING AND FLOORING MATERIALS

An investigation was commenced in June with a view to obtaining a road surfacing or flooring material from latex. In view of the partial success already achieved by the Rubber Research Institute and elsewhere with mixtures of latex and aluminous cement, attention was devoted in the first place to a study of the phenomena which occur during the setting of these mixtures. The investigations so far carried out indicate that (1) protective colloids (some of which are natural constituents of latex and others added to improve stability) retard and sometimes prevent the combination of the usual amount of water with cement

so that in some circumstances the bulk of the water remains in the mixture in a free condition except for loss by evaporation. (2) Potash and gum arabic hasten the setting of cement, but most protective colloids delay and sometimes prevent the setting. The effect is markedly dependent upon the amount of protective colloid used. (3) Different types of material can be obtained with the same proportion of latex and cement according to the material used to stabilise the latex. (4) A mixture of latex and cement after setting consists of comparatively large particles of unhydrated cement surrounded by a matrix which must contain the rubber and the hydration products of cement and water.

Although cement may not appreciably dehydrate latex it serves a useful purpose in causing the latex to set. It is evident however that previous ideas regarding the necessity of adding sufficient cement to combine with the water in latex require further consideration.

Nitrite crumb. (B.P. 395,775)

Reference was made in the previous report to preliminary road surfacing trials with "cold" asphaltic mixtures containing nitrite crumb and to arrangements which were made for laying a section of the public highway with the mixture giving the best results. The asphaltic cement containing rubber was prepared in the Committee's laboratories by a method developed by the staff and used to coat aggregate on the site, the total area covered being about 400 sq. yds. At the end of the year (7 months after laying) the road had a good matt non-skid surface, possibly due to the rubber preventing the flow of bitumen and polishing by traffic. In the opinion of the scientific staff of the Limmer and Trinidad Lake Asphalt Company, who collaborated in the work, the results are sufficiently promising to justify further trials on a more extensive scale.

Towards the end of the year a paper was compiled by Mr. W. S. Davey (Journal of the Society of Chemical Industry, March 6th, 1936, Vol. LV, No. 10, pp 43T-48T) on the effect of different types of crumb rubber and latex on the properties of asphalt after different periods and temperatures of heating. It was shown that rubber improves the properties of asphalt but the improvement becomes less marked with the period and temperature of heating. The solution of rubber in asphalt in the "hot" process would therefore yield variable products unless precautions were taken to standardise the period and temperature of heating. This is not practical on a large scale.

The use of nitrite crumb in combination with other substances for traffic lines continued during the year. The mixture has so

far given satisfactory results and there is a tendency for its use to increase.

Experiments by Messrs. Farmer and Bloomfield, who are investigating modified rubber for the Rubber Growers' Association showed that a sample of nitrite crumb had advantages in the preparation of chlorinated rubber owing to the ease with which solutions of low viscosity were obtained. Further experiments showed that a subsequent consignment was not so suitable. The difference in the results obtained is ascribed to a change in the method of preparing the crumb; in order to facilitate production and chlorination, experiments are now in progress with crumb prepared by modifications of the usual method. It is difficult during the development stage to standardise the method of preparing the crumb and it may be necessary eventually to compromise between the method found to be most convenient in the East and that which furnishes the most suitable crumb for different manufacturing purposes. The problem will be discussed with the Director of the Rubber Research Scheme, Ceylon, during his period of leave in 1936.

A study of the viscosity of solutions of the crumb in various solvents and the effect of different methods of preparation was made in the Committee's laboratories. It was shown that the method of preparation originally adopted gave thin solutions and that the viscosity of the solution could be reduced markedly by heating for about 1 hour at above 80°C. or by adding a small quantity of piperidine. This information was used in the preparation of paints containing rubber and the problem discussed with a paint manufacturer who is carrying out laboratory experiments.

As the crumb can be easily dissolved in butyl acetate it was mixed with solutions of nitrocellulose and bakelite resins in the same solvent but, in spite of the common solvent, difficulty was experienced in obtaining uniform and intimate mixtures of rubber dispersed in resin or nitrocellulose.

It was found that the crumb can be easily dissolved in waxes to give materials which are less brittle than wax and which adhere better to metal or wood surfaces. The use of the crumb to improve the properties of wax is now under consideration.

References were made in the previous report to the massing of crumb during transit. Samples were received dusted with various amounts of French chalk and zinc stearate respectively. Those dusted with zinc stearate showed less tendency to mass than the others and consignments are now dusted with this material.

Types of Rubber required by Manufacturers.

As explained in previous reports there is a demand for very soft rubber and also for rubber with low water-absorption. Experiments on their production have been made previously in the East and in London but owing to a number of circumstances little attention has been given to the problem during the year. Methods to be employed were discussed with Dr. Rhodes while on leave and arrangements made for further experiments.

Dr. Stevens suggested that it would be of interest to determine the effect of the addition of copper and cobalt compounds to latex prior to coagulation with a view to obtaining a material which would be of value for purposes not connected with the rubber manufacturing industry. Tests on the rubber in London showed that cobalt sulphate had no appreciable effect on the properties of the rubber but confirmed that copper sulphate caused marked softening.

Some difficulty has been experienced in assessing the value of various treatments devised by the Rubber Research Institute for preparing rubber with low water-absorption because the same test gave different results in Malaya and London. The problem was discussed at a meeting attended by representatives of the Electrical Research Association, the Research Association of British Rubber Manufacturers and Dr. Rhodes. The latter pointed out that American rubber manufacturers used a different method. The discussions indicated that there were good reasons for preferring the method adopted and it was decided not to make any change.

Factors which might affect the results of tests were studied with a view to determining the cause of discrepancies in London and Malaya. It was shown that the thickness of the test specimens (within the limits of the experiments), the age of the rubber and the temperature of testing had little effect. Some evidence was obtained however that it was necessary to maintain a uniform temperature throughout the test as there was a lag in the humidity of the moisture chamber with variation in temperature. Experiments are now conducted in London at 85° $\pm$ 1°F. and the results of tests are so far similar to those obtained in Malaya.

Samples of rubber were received from the Rubber Research Institute of Malaya which had a low water-absorption in accordance with the standard arbitrarily adopted at the above conference. These were sent to the Research Association of British Rubber Manufacturers for examination in connection with their efforts to prepare ebonite with improved properties.

Clone Rubber

In connection with the investigation in progress on the properties of clone rubber, samples of smoked sheet from five different clones were examined. They gave satisfactory results but it is undesirable to draw premature conclusions from or to publish the results of isolated tests. It is hoped to review the position when more samples have been examined from a range of sources and prepared under different conditions. Hitherto it has been difficult to obtain samples from mature trees planted on an extensive scale, but this difficulty is now disappearing and it is expected that an increasing amount of attention will be required to obtain full and authentic information concerning the quality of clone rubber.

Testing of Rubber

A comparison of the results of tests by the Goodyear Rubber Company and the Committee showed that identical samples of smoked sheet appeared to have much better ageing properties when tested by the Goodyear Rubber Company than when tested by the Committee. Mr. Patterson of the Goodyear Rubber Company, Wolverhampton, therefore kindly co-operated in a series of tests which eventually showed that the difference was due to the treatment of the samples in the ageing oven, those in the Committee's laboratories being kept in motion and those in the Goodyear laboratories stationary. Both arrangements show the same relative differences between samples but the Committee's method is preferred by the staff because it is easier to obtain uniform conditions.

A further series of comparative tests were carried out in which a comparison was made of ageing with different mixings, periods of vulcanisation, types of test specimens in ageing ovens and vulcanising pans. This involved a considerable amount of work both by the Goodyear Rubber Company, Wolverhampton and the Committee. The results obtained provided a large amount of data of value in standardising the methods employed for the testing of rubber.

A series of vulcanisation tests on samples of clone rubber were carried out in the Committee's laboratories and those of the Rubber Research Institute of Malaya. The samples examined in Malaya vulcanised about 20 per cent more quickly than those in London but on the whole the samples displayed the same relative differences in both countries.

In view of the effect of atmospheric temperature on the results of mechanical tests on vulcanised rubber, the Schopper

machine at the Imperial Institute has been housed in a small room maintained at 85° ± 1°F. It is expected that this arrangement will enable results to be obtained in this country comparable with those obtained in the East.

G. Martin

Superintendent of Rubber Investigations.

Imperial Institute,

London, S.W. 7.

May, 1936.